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FAUNA OF THE GATUN FORMATION, ISTHMUS OF PANAMA.

BY AMOS P. BROWN AND HENRY A. PILSBRY.

The collection of fossils studied in this paper was made by one of us (Brown) during two visits to the Isthmus in April and in August, 1910. With the exception of a tooth of a shark¹ and a few specimens of *Oliva* from Monkey Hill all come from the excavations for the locks at Gatun. The *Oliva* taken at Monkey Hill is the same species found plentifully at the Gatun excavation. The specimens were collected from dumps and fills along the railway as well as from the dumps in the vicinity of Gatun.

A rapid reconnaissance of the stratigraphy along the line of the railway from Colon to Empire and along the canal from Colon to Gatun seemed to indicate that the formations, from the highest exposures at Monkey Hill (Mount Hope) to the lowest that contain molluscan remains at Bohio, form one stratigraphic unit, the base of which is to be found at Bohio and the top at Monkey Hill. This was the impression formed by a study of the stratigraphy on the ground. As shown below, the study of the fossils collected, and a survey of the literature on the Isthmian formations, bears out his impression formed in the field. The thickness of this Gatun formation is probably not much above 400 feet, judging from exposures and borings at Gatun. It is dredged from the canal at more than four miles north of Gatun, being here encountered at 18 feet below water level.

If this is correct that the mollusk-bearing formations from Bohio to the sea at Colon form one stratigraphic unit (and they appear to be one faunal unit), the Gatun Formation will include beds that have been variously called Bohio, Gatun, Monkey Hill, Culebra and Vamos-Vamos.

The recognition of Eocene in the Isthmian section rests upon fossils from the "Vamos á Vamos or Gatun beds" collected by Robert T. Hill and examined by Dr. Wm. H. Dall. These fossils occur as "pseudomorphs in calcite in a tough matrix, and difficult to extract in good condition." The following Eocene (Claiborne) species were "noted on a rapid examination"² by Dr. Dall:

¹ *Carcharias megalodon* Ag.

² *Bull. Mus. Comp. Zool.*, vol. 28, p. 273. The genera noted without specific identifications are such as are found in the Oligocene beds.

Lupia perovata Conrad.

Solarium alveatum Conrad.

Natica eminula Conrad.

To which the following were subsequently added:

Corbula alabamiensis Lea.

Corbula gregorioi Cossmann.

The shell identified as *Lupia perovata* may turn out to be "*Amaura*" *guppyi* Gabb, of the Santo Domingo Oligocene, a species which resembles the Eocene form so closely that very well-preserved examples are necessary for their discrimination.

The genus *Glyptostyla*, represented by *G. panamensis* Dall, is known elsewhere only from the Upper Tejon Eocene of California, where a species very distinct from the *Vamos á Vamos* form occurs.

The condition of the calcite pseudomorphs at Gatun is often not favorable for exact determination, and it seems possible that some of the identifications with Claibornian species might be modified by the study of perfect examples.³ The presence of a few Claibornian species belonging to genera not characteristically Eocene in a fauna predominantly Oligocene does not, it seems to us, justify a reference of the formation to the Eocene. Until a longer list of Eocene species including some characteristic forms is made known, we are disposed to regard all of the known tertiary beds of the Canal Zone carrying molluscan fossils as Oligocene and as constituting one formation. The exact position of the Gatun Formation among Antillean Oligocene formations cannot be fixed without a more complete list of the contained fossils than we now possess, but its approximate place is clear. As Dall has shown, the Jamaican (Bowden) marl, by the absence of *Orthaulax* and the greater proportion of modern species, is probably somewhat later than the Santo Domingo beds. The Gatun formation, as now imperfectly known, has decidedly more in common with the older and more remote Santo Domingan than with the later and geographically nearer Bowdenian.

It contains many species common to both beds, and a few show greater affinity to Bowden forms. Some of the difference between the Isthmian and Santo Domingo faunas is doubtless due to local specific differentiation; possibly this factor may account for all the differences; yet on the whole we conclude that the Gatun fauna is slightly later than the Santo Domingo and earlier than the Bowden.

³ We express this possibility in view of the imperfection of the material and with all respect for Dr. Dall's opinion, which is justly considered authoritative in such matters.

Gatun species identical with those of Santo Domingo.....	22
Gatun species identical with those of Bowden.....	13
(Eight of the species are common to the Santo Domingo and Bowden beds.)	
Gatun species more closely allied to those of Santo Domingo and Bowden than to any other known forms.....	20
Gatun species identical with those of Chipola.....	4
Gatun species identical with recent forms.....	6
Gatun species as yet known only from that formation.....	67

It will be noted that at least 40 per cent. of the 104 Gatun species now known are either identical with, or very closely related to, Santo Domingo forms. A considerable proportion of the remaining species are certainly allied to those of Santo Domingo, but without exhaustive studies of the groups, their nearest affinities cannot readily be determined.

Of the 6 species identical with recent forms, 4 are Antillean, one inhabits both coasts and one the Pacific coast only. It is obvious that in the Antillean and Isthmian Oligocene the ancestral stocks of a large part of the modern Antillean and Panamic faunas are present, genera now characteristically Panamic being especially well-developed, such as *Cymia*, *Solenosteira*, *Strombina*, *Malea*, *Trachycardium* of the *belcheri* group, *Clementia*, *Acila*, *Tesseracme*, *Cadulus* of the *dentalinus* group, etc. None of them are deep-water forms, and all are absent or rare in the curiously impoverished littoral Antillean fauna of the present time.⁴

In the following list we have included all species reported from the Gatun beds. Species marked with an asterisk (*) were not included in the collections we have studied. With a few exceptions noted in the text, the other species listed are in the collection of the Academy.

Acknowledgments are due to Professor Wm. B. Scott and Mr. Gilbert Van Ingen for the privilege of studying a small series of Gatun specimens in the museum of Princeton University, collected in 1908 by Mr. Ward H. Farrington. We would also acknowledge the courtesy of Dr. Wm. H. Dall, in giving access to material in the U. S. National Museum.

Genera reported by Toula and Hill without specific identifications have not been inserted in the following list.

⁴ Hill's statement (Bull. Mus. Comp. Zool., vol. 28, p. 265) that Pacific forms do not exist in the Antillean Oligocene is clearly at variance with the facts. An important element in the littoral fauna of the Panamic province is directly traceable to Antillean Oligocene faunas, as the above list demonstrates.

ACTEONIDÆ.****Bullina chipolana* Dall.**

Bullina (Abderospira) chipolana Dall, Proc. U. S. Nat. Mus., XVIII, p. 32.

Chipola beds, Chipola River, Florida; near Gatun, Rowell (Dall).

SCAPHANDRIDÆ.****Volvulella* sp. undet.**

Bulla (Volvula) cf. oxytata Bush, Toulou, Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt, LVIII, 1908 (April 15, 1909), p. 709, Pl. 28, fig. 4.

Gatun.

TEREBRIDÆ.***Terebra subsulcifera* n. sp. Pl. XXII, fig. 7.**

The shell is slender, the diameter contained about $7\frac{1}{2}$ times in the length, composed of about 15 whorls in a length of 31 mm. Sculpture: A prominent band below the suture, fully one-third the width of the whorl; below it, and separated by a sulcus, another band half as wide, below which there are weak, nearly obsolete spiral striæ; the whole crossed by rather sharp vertical riblets narrower than their intervals. These are very slightly oblique on the upper band, vertical on the sunken lower part of the whorl. The riblets gradually weaken below the middle of the last whorl, leaving the base smooth. The columella is strongly biplicate, the folds subobsolete at the aperture.

Length 31, diam. 7 mm.

This species has much in common with *T. haitensis* Dall, but it differs by having two columellar folds among other minor differences. A comparison kindly made by Dr. Dall shows them to be distinct. *T. sulcifera* Sowerby, of the Santo Domingo Oligocene, is described as having a third subobsolete spiral sulcus, while the species under consideration has only two sulci.

***Terebra gatunensis* Toulou. Pl. XXII, fig. 2 ($\times 2\frac{1}{2}$).**

Terebra (Oxymeria) gatunensis Toulou, Jahrb., p. 705, Pl. 25, fig. 14.

This fine species reaches a length of 50 to 60 mm. The subsutural band is about one-fourth the width of the whorl, with sculpture of straight, vertical ribs, and is followed by a rather wide furrow, below which there are seven rounded spiral cords, the upper one larger. Fine, slightly bent, longitudinal ribs run from suture to suture over cords and intervals, forming rounded knots at the intersections. These ribs are about twice as far apart as the spiral cords on the upper whorls, but on the later ones the cords and ribs are about equally spaced. On the last whorl the siphonal fasciole is marked with rude

growth-lines and lamellæ and bounded by a keel. Aperture narrow and long. The specimen figured, broken at both ends, is 51 mm. long, composed of 13 whorls. Toulà's description and figure were from a young shell.

Fig. 2 is typical. Six specimens seen. We doubt whether the following form is specifically distinct, so widely it varies in sculpture. The recent *T. panamensis* Dall has some resemblance to this species. A complete specimen measures, length 52, diam. 10.5 mm.

Terebra wolfgangi Toulà. Pl. XXII, figs. 1, 3-6 ($\times 2\frac{1}{2}$).

Terebra (Oxymeria) wolfgangi Toulà, Jahrb., p. 705, Pl. 28, fig. 7.

Very closely related to *T. gatunensis*, perhaps only a form of that species, from which it differs by having several weak spirals on the sutural band, running over ribs and intervals, and in the smaller number of spiral cords below the band, there being five, equally spaced, on the penultimate whorl, four on the median and upper whorls. The rate of increase of the whorls is about the same as in *T. gatunensis*. Judging from a number of incomplete shells, an adult of 50 mm. length should have about 20 whorls, of which fully 3 form a narrow, high, smooth embryonic shell.

This species is somewhat related to the Pliocene and recent *T. dislocata* Say, and especially to the preceding species. It varies widely in sculpture, as follows:

1. Sutural band differentiated on the early whorls, but on the last 3 or 4 not set off from the other spirals by a deeper furrow; 4 spiral cords as wide as their intervals below it; vertical sculpture fine and low on the later whorls, weak in the intervals of the spirals. One specimen (Pl. 22, fig. 1).

2. Typical form, described above, 2 specimens.

3. Sutural band divided by one shallow sulcus in the intercostal spaces only. Spiral cords unequal, three in a group, followed by two separated by wider spaces. Only 12 spirals on the last whorl below the band. One specimen (figs. 3, 4).

4. Sutural band with several spiral striæ indenting the ribs and intervals. Spiral cords unequally spaced. Two specimens (figs. 5, 6).

Terebra gausapata n. sp. Pl. XXII, figs. 8, 9.

A small, slowly tapering species, with very slightly convex whorls and well-impressed, undulating suture. Sutural band limited by a deep, narrow sulcus and, like the rest of the whorl, sculptured with close, unequal, spiral threads. There are three threads upon the band, eight below it. There are fourteen high, rather narrow, longitudinal

ribs on each whorl, the threads obsolete on their summits. The imperfect shell figured measures, length 9, diam. 2.8 mm., of $6\frac{1}{2}$ whorls.

CONIDÆ.

Conus concavitectum n. sp. Pl. XXIII, figs. 5, 6.

A cone about twice as long as wide. Spire very concavely conic or mucronate, the inner whorls forming a very steep, acute cone, its whorls carinate below the middle of each, sloping and usually marked with a faint impressed spiral line or two above the carina, or having several striæ on the lower part of the slope, where the carina lies in the suture. The last 3 or 4 whorls revolve nearly in a plane, are markedly concave, with the outer edge raised in an erect flange or keel, the concavity marked with one or several spiral threads and distinct, arched growth-striæ. Last whorl slightly convex below the shoulder-angle, straight and slender below, marked below the middle with unequal, low spirals, most of them beaded. Length 37.5, diam. 19 mm. Incomplete adult shells are much larger, diam. 28 mm., with about 15 whorls.

This species differs from *C. domingensis* Gabb by having the outer edge of the later whorls raised in a flange and by the smooth, not tuberculate early whorls. None of the larger specimens is complete.

Conus haytensis Sowb.

Conus haytensis Sowb., Journ. Geol. Soc. Lond., VI, p. 44.

A perfect, but small specimen, length 26 mm., agrees with Santo Domingo examples.

Conus domingensis Sowerby (?).

C. domingensis Sowb., Journ. Geol. Soc. Lond., VI, p. 45.

A fragment, the spire only, agrees well with this species, so far as it goes.

Conus consobrinus Sowb.

Conus consobrinus Sowb., Journ. Geol. Soc. Lond., VI, p. 45.

A Gatun specimen is about 30 mm. long, of the highly sculptured typical form.

Conus granozonatus Guppy.

C. granozonatus Guppy, Quart. Journ. Geol. Soc. Lond., XXII, p. 287, Pl. 16, fig. 5.

C. gracilissimus Guppy, t. c., p. 288, Pl. 16, fig. 4.

Not uncommon at Gatun. While closely related to *C. consobrinus*, this seems to be a distinct species. In our series from Bowden the *C. gracilissimus* does not seem distinguishable specifically.

Conus æmulator n. sp. Pl. XXIII, fig. 9.

A cone related to *alveatus* Conr. and *imitator*, differing from both in the very concavely conic spire. Whorls slightly concave above, with about 3 spiral striæ; not tuberculate, last whorl decidedly convex below the shoulder, its lower half spirally striate, the striæ unequal, not beaded. The outer lip is much less retracted above than in *alveatus*.

Length 22.5, diam. 12.8 mm.; whorls about 9.

The single specimen is a pseudomorph in calcite. It differs from *C. domingensis* by the non-tuberculate early whorls.

Conus imitator n. sp. Pl. XXIII, fig. 4.

A cone about twice as long as wide, the spire forming about one-fourth of the length. The spire is concave and acuminate in the upper third, the first 3 whorls smooth, the next 4 or 5 whorls having a smooth carina projecting above the suture, the first $2\frac{1}{2}$ of them tuberculate, after which the carina is smooth; following whorls less steeply sloping, very slightly concave, marked with fine growth-lines and a few weak spiral striæ, slightly prominent at the sutures. Last whorl acutely carinate, the slope below the angle almost straight, but just perceptibly convex in the upper, concave in the lower half, which is sculptured with about 16 rather strong spiral cords. The outer lip arches strongly forward and is deeply retracted at the upper end.

Length 35, diam. 17 mm., whorls 12.

This small, inornate cone is probably a descendant of *C. alveatus* Conr. of the Vicksburgian, but in that species the spire is more strongly striate, more whorls are tuberculate, and the keel edging the whorls is directed upward, whilst in *C. imitator* it is rather outward.

It is rather abundant at Gatun. Also occurs in Santo Domingo.

Conus gaza Johnson and Pilsbry, n. sp. Pl. XXIII, figs. 2, 3.

"The shell is biconic, diameter over half the length, the spire is nearly one-third the total length, concavely conic, attenuate towards the apex. Post-embryonic whorls about 9, slightly concave, the lower edge of each angular, projecting a little; the angle tuberculate in the first post-embryonic whorl, smooth in the rest; sculptured with deeply arcuate, narrow, low and widely spaced riblets and striæ; no spiral striæ. Last whorl acutely angular at the shoulder, barely convex below the angle, the outline becoming concave in the lower part; sculptured with 20-22 strong, smooth, flattened spiral cords, separated by wider intervals which are sharply striated by growth-striæ. Aperture very narrow.

"Length 24, diam. 13.1 mm." (Johnson and Pilsbry).

Oligocene of Santo Domingo, Gabb. Also of Gatun, A. P. B.

This beautiful cone bears some resemblance to the longer *C. cruzianus* Dall from Santa Cruz, the horizon of which is uncertain.

The single specimen from Gatun has fully two tuberculate post-embryonic whorls. In the Santo Domingo types this stage is shorter, and generally inconspicuous or lost by erosion. We have quoted the description from Pilsbry and Johnson's MS. work on the Santo Domingo Oligocene. The figures represent the type specimens from the same place.

Conus molis n. sp. Pl. XXIII, fig. 1.

A large, ponderous cone resembling *C. promethus* in figure, the ratio of diameter to length as 1 : 1.7.

Spire but little raised except at the center, where the early whorls project in a short acute cone. Whorls about 13, the earlier 6 flat, later whorls concave, spirally striate with about 5 striæ between the seamlike sutural margins; crossed by weak growth-lines, which are not very deeply arcuate. The shoulder of the last whorl is subacute. Side strongly convex below the angle, then straight, finely striate spirally throughout, the lower third coarsely striate. Aperture as in *C. haytensis* Sowb.

Length 124, diam. 71.2 mm.

This cone resembles *C. haytensis* Sowb. of Santo Domingo, but differs by being longer in proportion to its width, in the plain, not coronated early whorls, which form a smaller mucro, the more acute shoulder, below which the side is more convex, *more distinctly striated*; the striæ at the base are more nearly equal and closer, not widely spaced with smaller striæ in the intervals, as they are in *haytensis*.

The type is No. 5,502 coll. Princeton University, collected by Ward H. Farrington, 1908.

This species is also represented by several internal casts in the Princeton and Academy Gatun collections, and there is a fine example in the U. S. National Museum from Monkey Hill, near Colon. Toulà also mentions a cast, probably referable to the same species (Jahrb., p. 754).

TURRITIDÆ (PLEUROTOMIDÆ).

Pleurotoma albida Perry.

The specimens agree well with those of the Bowden beds. It is a conservative species, ranging from Eocene to recent.

Drillia gatunensis Toula.

D. gatunensis Toula, Jahrb., p. 707, Pl. 25, fig. 16.

Related to *D. indentata* J. and P., of the Santo Domingo Oligocene, but it differs by having more numerous spirals. In this feature there is rather wide variation, many specimens having but four wider spiral cords on the whorls of the spire below the sutural fasciole. It attains a length of 40 mm.

Drillia isthmica n. sp. Pl. XXIII, figs. 10, 11.

A small species, related to *D. parkeri* Gabb of the Santo Domingo Oligocene, $2\frac{1}{2}$ or 3 smooth whorls compose the embryonic shell, which is somewhat worn. Succeeding whorls have a distinct, narrow, convex, sutural fasciole, undulating in conformity with the suture, and rather weakly plicate, the plicæ perceptibly retractive, unevenly developed. Below the fasciole there are broad folds, subacute at their summits. On the slopes of the folds there are some protractive wrinkles, like ripples upon waves. There is an interrupted spiral groove midway between sutures, appearing as a series of short strokes in the troughs of the waves only. The aperture is imperfect in the type specimens. There is a small callous nodule on the left side of the posterior sinus.

Length 13 mm., 11 whorls.

The absence of spiral striation makes this species quite distinct from others of the Isthmian beds.

Drillia fusinus n. sp. Pl. XXIII, fig. 7.

The shell is fusiform, widest at the middle, like a slender *Fusinus* (*Fusus*). Spire attenuated towards the small, obtuse apex. The first half whorl is rounded, uptilted; then an acute carina appears at the lower third, at the end of the first whorl a second small cord appears above the suture. Beginning with the third whorl a small thread appears on the upper side of the main carina, and low longitudinal folds begin. On subsequent whorls these folds continue to the penultimate. They are low, very wide and on the last whorl subobsolete. The penultimate whorl has four subacute main spirals, one subsutural, two peripheral and one suprasutural; the intervals bearing smaller spiral threads and striæ. The last whorl has many spiral cords and threads. Whorls 12, concave above, the last one swollen in the middle, concave and extended in a long, straight anterior canal. Aperture narrow, small, less than half as long as the anterior canal, not deeply sinuated above.

Length 40, diam. 12 mm.

This appears to be a rather abundant shell at Gatun, but only one out of ten specimens retains the long anterior canal entire. It is extremely like *Fusinus* in contour, and is more nearly related to *D. fusiformis* than to other species known to us.

Drillia zooki n. sp. Pl. XXIII, fig. 8.

A species very closely related to *D. fusiformis* Gabb, of the Santo Domingan Oligocene, but differing as follows: The anterior canal is much shorter. There is no cord at the lower edge of the sutural fasciole, above the suprapерipheral cord. There are eleven somewhat protractive longitudinal folds on the last whorl, which are narrower than in *D. fusiformis*. In other respects the two species seem to be substantially alike.

Length of last 4 whorls 20.5, diam. 8.5 mm.

Only imperfect specimens were collected. Named for Mr. E. Zook, of the Panama R. R.

Drillia consors (Sowerby).

Pleurotoma consors Sowb., Journ. Geol. Soc. Lond., VI, p. 50.

The Gatun specimens seem to have a slightly longer anterior canal than those from Santo Domingo.

***Pleurotoma gertrudis** Toula.

Pleurotoma (Genota) gertrudis Toula, Jahrb., p. 709, fig. 9.

Cythara heptagona (Gabb).

Mangelia heptagona Gabb, Geol. Santo Domingo, p. 211.

One typical specimen.

CANCELLARIIDÆ.

Cancellaria dariena Toula. Pl. XXIV, figs. 3, 4.

C. dariena Toula, Jahrb., p. 703, Pl. 25, fig. 13; Pl. 28, fig. 2.

This species resembles *C. reticulata* very closely, yet differs by having a much larger embryonic shell which is also more globose, of three whorls. There are about $5\frac{1}{2}$ post-embryonic sculptured whorls, while in *reticulata* there is at least one whorl more in shells of the same size. The first sculptured whorl in *C. dariena* has five spiral cords and 10 or 11 massive longitudinal folds. On the last whorl there are usually some smaller threads in the intervals between the principal spirals, above the periphery. The aperture is very much like that of *C. reticulata* except that a thin callus spreads far forward over the whorl to the middle of its ventral face.

Length 30, diam. 16.5 mm.

A form which may be called *Cancellaria dariena trachyostraca*,

n. subsp. (Pl. 24, figs. 1, 2), has the same comparatively large embryo, but the first sculptured whorl has about 16 more numerous, much narrower ribs. On the last whorl the spirals are equal, without spiral threads in the intervals. The callus does not extend forward from the aperture quite so extensively.

Length 30, diam. 18 mm.

Cancellaria barretti Guppy, which is very similar in appearance, has more spiral cords and more liræ within the outer lip.

Cancellaria decaptyx n. sp. Pl. XXIV, figs. 5, 6.

A small, slender species, composed of 7 whorls in a length of 11 mm. The first $2\frac{1}{2}$ whorls form a smooth naticoid embryonic shell; then three spiral cords appear, and soon after coarse, rounded longitudinal ribs. The spirals increase rapidly in number on succeeding whorls. They pass over the ribs, upon the crests of which they are slightly strengthened. The ribs are not quite as wide as their intervals. On the last whorl there are ten, on the preceding nine ribs. Whorls strongly convex. The aperture is small. Columella with two moderate, oblique folds, which are somewhat receding, being only weakly visible in a front view.

Length 11, diam. 5 mm.

We find no closely related species in the American tertiary.

MITRIDÆ.

Mitra longa Gabb. Pl. XXIV, fig. 11.

M. longa Gabb, Geol. of Santo Domingo, p. 219.

The specimens agree well with Gabb's types of this species. As it has not been illustrated, we figure one of the Gatun specimens. It measures, length 37, diam. 9.1 mm.

Mitra dariensis n. sp. Pl. XXIV, fig. 9.

A species closely related to *M. longa*, but shorter, the diameter contained about three times in the length. The apex is lost, $6\frac{1}{2}$ whorls remaining. These are rather convex, with sculpture of four strong equal spiral ridges, and a smaller thread just below the suture; and on the last three whorls another thread appears between the first and second of the spiral cords. The last whorl has twelve major spirals, and about six small, subequal spirals on the siphonal fasciole. The interstices are sculptured with rather close, sharp longitudinal threads, and in each a spiral sunken line revolves. The aperture is narrow. Columella with four strongly oblique folds, the lowest one very small, upper fold much the strongest.

Length 22, diam. 7 mm. (apex wanting).

This species differs from *M. longa* chiefly by the shorter, less contracted basal portion of the last whorl and the somewhat different sculpture of the interstices between the smooth spiral ribs.

Mitra sp. undet. Pl. XXIV, figs. 7, 8.

The internal cast of a large Mitre having three columellar plaits, the median one strongest, and with unusually short whorls, contained in the Princeton collection, No. 5,515, is figured (fig. 8). Length of the fragment, which comprises nearly 2 whorls, is 46.5 mm.

A short piece of the columella of what we take to be the same species, was taken by one of us (fig. 7). It shows three sharp plaits, the middle one largest, and on the wall above the upper plait there are several spiral threads.

This species is distinct from any known Santo Domingan *Mitra*.

MARGINELLIDÆ.

Marginella gatunensis n. sp. Pl. XXIV, fig. 10.

A rather small oblong shell, widest at the upper third of the length, the diameter contained about 1.8 times in the length. The spire is conic, short, and so enveloped in callus that the sutures are obliterated. The outer lip is rather broad, thickened outside, incurved, and delicately denticulate within. The nearly straight narrow aperture is rather abruptly but slightly dilated near the lower end. The columella bears four folds, the lower two or three a little flattened towards the outer ends. Upper half of the columellar wall is somewhat calloused, but thin at the outer edge.

Length 11.5, diam. 6.25 mm. (type).

“ 8.5, “ 4.8 “

This species is clearly distinct from all described from the American Oligocene. It has some resemblance to *M. limonensis* Dall, of the Costa Rican Miocene (?), but that is more than double the size of the largest *M. gatunensis* seen, and is relatively narrower.

Marginella leander n. sp. Pl. XXIV, fig. 13.

The shell is long and narrow, the diameter not quite half the length; approaching a cylindric contour, but tapering a little from the upper fourth to the base; the spire a very short, wide cone, obtuse and rounded at the summit. The aperture is straight, very narrow in the upper moiety, the lower third decidedly wider. Outer lip nearly straight, with narrow, rounded face, thickened externally, a little inflexed in the middle. Columella bearing four rather small folds, which run outward upon the ventral face of the shell. There is a

low callus upon the columellar wall above. The anterior notch is rather wide and shallow.

Length 9.0, diam. 4.2 mm. (type).

“ 8.6, “ 4.1 “

Chiefly notable for its narrow shape and the long, emerging columellar folds. Named for the Rev. Leander T. Chamberlain.

Marginella coniformis Sowb. Pl. XXIV, fig. 12.

Marginella coniformis Sowb., Journ. Geol. Soc. Lond., VI, p. 45 (Santo Domingo).

The specimens agree very closely with the small Bowden race of this species, which has been very poorly figured by Guppy (Q. J. Geol. Soc., XXII, Pl. 17, fig. 2); but the Gatun shells are even smaller. Specimens measure:

Length 15.8, diam. 9.7 mm.

“ 14.3, “ 9.1 “

M. ballista Dall is broader at the shoulder, but otherwise related.

OLIVIDÆ.

Oliva reticularis gatunensis Toulal.

Oliva gatunensis Toulal, Jahrb., p. 702, Pl. 25, fig. 12.

Cf. *Oliva lioedes* Dall, Trans. Wagner Inst. Sci., Pl. 58, fig. 1.

This abundant form is not really distinguishable from the living *O. reticularis*, except by its smaller size, length 35 to 38 mm.

FASCIOLARIIDÆ.

***Glyptostyla panamensis** Dall.

Glyptostyla panamensis Dall., Trans. Wagner Inst. Sci., III, p. 233, Pl. 13, fig. 5.

Not seen by us. Vamos-vamos Station, 19 kilom. from Colon. The genus *Glyptostyla* is also known from the Martinez Eocene of California, but the species of that bed, *G. crassitesta* (Gabb), is very unlike the Isthmian form in sculpture, and cannot be considered nearly related.

Fasciolaria sp. undet.

Internal casts of a species not unlike the Chipolan *F. ramondi* Maury were taken at Gatun.

BUCCINIDÆ.

Solenosteira dalli n. sp. Pl. XXIV, fig. 14.

The shell is biconic, solid and thick. Spire conic, acuminate when perfect, with about $2\frac{1}{2}$ smooth embryonic whorls, the following whorls very convex, with sculpture of massive longitudinal folds not quite as wide as the intervals, and sharp spiral cords and threads passing

over folds and intervals. On the last whorl there are 8 or 9 short, high folds, narrower than the intervals, and somewhat pointed at the shoulder, and sharp spiral cords, the concave intervals of which bear several unequal spiral threads. There are 16 or 17 major spirals between the suture and the basal point of the outer lip, and 5 or 6 more small ones on the convex basal fasciole. The whole surface between the spirals is marked with fine growth striæ. The last whorl is deeply concave below, expanded around the umbilicus, which is deep and funnel-shaped. Aperture as in the type of the genus, except that there is no posterior channel, merely an angle. Outer lip deeply sulcate within, with crenulate edge. Columella nearly straight. Parietal callus thin, with raised edge and one or two small liræ near the posterior angle of the aperture.

Length 41, diam. 25 mm.

This fine species bears the name of Dr. William H. Dall, whose "Tertiary Mollusks of Florida" is the greatest classic of the American Neocene.

It is evidently close to the recent *S. anomala* (Reeve), the type of *Solenosteira*, but differs by the greater number of spiral cords and the absence of an expansion or incipient channel at the posterior angle of the aperture. We know *S. anomala* only by Reeve's too brief account. It is probably a species of the Panamic region. *S. pallida* (Brod.), which Tryon considers identical with *anomala*, has more folds, 10 or 11 on the last whorl in specimens examined, and they are obtuse, not pointed as in *S. dalli*; the spiral cords are much less prominent, their intervals nearly flat instead of concave, and bear finer, less unequal threads; moreover, there is a well-marked posterior apertural sinus in all of the specimens examined, while in *S. dalli* there is none.

Solenosteira elegans Dall (Bull. Mus. Comp. Zool., XLIII, p. 300) from the Gulf of Panama, is a more compact shell than *S. dalli*, with narrower, longer ribs. *S. vughani* Dall, from the Floridian Miocene, is also related. The last surviving *Solenosteira* in Antillean waters was *S. mengeana* Dall, from the Caloosahatchie Pliocene.

Phos gatunensis Toula. Pl. XXV, figs. 1, 2.

Phos gatunensis Toula, Jahrb., p. 701, Pl. 28, fig. 6; Pl. 25, fig. 11.

Toula's specimens of this species were poor, so that further descriptive notes and figures may be useful. It differs from *Phos metuloides* Dall, from the Oligocene of Monkey Hill, by having rather narrow and sharp spirals, not in the least straplike at any stage of growth, and there are not so many longitudinal ribs. *Phos gabbi* Dall, from the Oligocene of Santo Domingo and Jamaica, is very closely related to

P. gatunensis, but in *gabbi* the aperture is shorter and wider, in consequence of the more swollen last whorl.

The embryonic shell consists of two smooth, rounded whorls; then narrow, widely spaced protractive riblets, and a spiral carina at the lower third, appear, for a half-whorl, giving place then to rounded vertical ribs about equal to their intervals, and spiral cords passing over ribs and intervals, the spaces between them spirally striate. On the last whorl there are 13 narrow spiral cords above the siphonal fasciole, which is bounded above by an acute ridge. The cords are enlarged where they pass over the longitudinal ribs, and in each interval there are several spiral striæ except in the subperipheral region, where each interval has one spiral thread. On the convex siphonal fasciole there are 4 to 6 small cords. Adult shells have 19 to 25 longitudinal ribs on the last whorl. On the preceding whorl the number is diminished by about a fourth. There is no varix behind the outer lip, but the ribs become obsolete there in fully adult shells. The aperture is narrow and long, the outer lip strongly lirate within. The columella bears, at the origin of the anterior canal, a strong, obtuse, spirally entering plait, which ascends the internal column.

Length $32\frac{1}{2}$, diam. 15 mm.

“ 30, “ 14 “

“ 25, “ 12 “

There is rather wide variation in the number of longitudinal ribs, while the number of major spirals remains very constant—thirteen on the last whorl, the upper one being more or less obviously doubled.

Phos subsemicostatus n. sp. Pl. XXV, fig. 3.

This species is closely related to *Phos semicostatus* Gabb, of the Santo Domingo beds. It differs by having slightly narrower more numerous spiral threads, and by lacking small longitudinal riblets between the rare, varix-like ribs of the later whorls. It is also larger.

Length 42, diam. 19 mm.; 10 whorls.

Further material may perhaps show this to be a subspecies of the Santo Domingan form. Our type has lost a large part of the shell from the last two whorls.

Phos metuloides Dall.

Phos metuloides Dall, Proc. U. S. Nat. Mus., XIX, p. 303, Pl. 28, fig. 15 (Ponton, Santo Domingo; Monkey Hill, Isthmus of Panama).

Several young specimens from Gatun show the embryonic and early neanic whorls. There is an embryo of at least 3 smooth whorls; then appear about five spiral threads crossed by very slender, widely spaced, protractive ribs. These gradually change, in the first sculp-

tured whorl, to coarse, rounded, vertical ribs equal to their interstices. These continue for about two whorls, after which the adult sculpture of fine, close vertical riblets sets in, either abruptly or by a short but gradual transition.

Metula gabbi n. sp. Pl. XXV, figs. 4, 8.

This species is represented by three broken specimens, the spire, beyond the penultimate whorl, being wanting. It is closely related to *Metula cancellata* Gabb, from which it differs as follows. The sculpture of narrow longitudinal folds and spiral cords is much coarser. There are 40 to 43 spirals on the last whorl (counting the smooth ones at the anterior end). In *M. cancellata* the upper two or three spirals are separated by wider or deeper grooves than the rest, but in *M. gabbi* this is not the case. The longitudinal folds on the last whorl of *M. gabbi* are about twice the size of those of *M. cancellata*. On the spire the spirals do not pass over the longitudinal folds in *M. gabbi* as they do in *M. cancellata*. The apertures are alike in the two species. In the largest Gatun specimen the last whorl, measured in front, is 20.5 mm. long.

COLUMBELLIDÆ.

Anachis fugax n. sp. Pl. XXV, fig. 5.

A species of the *A. avara* group, slender, with long, acuminate spire. The first whorl is very minute; embryonic shell conic, composed of 3 or $3\frac{1}{2}$ convex, smooth whorls, which taper more rapidly than the following whorls. The next two whorls are smooth; then longitudinal rounded ribs gradually begin, increasing in size to the last whorl. These ribs arch backward or are nearly straight, extend from suture to suture and are a little wider than their intervals. On the last whorl they weaken below the periphery. There are 3 to $3\frac{1}{2}$ rather convex sculptured whorls, separated by an impressed suture, below which there is a narrow ledge or indistinct cord. The basal half of the last whorl is coarsely lirate spirally, the spirals coarsest in the concavity of the base. Above the periphery and on the spire, spirals are wanting or sometimes barely traceable in places, but just behind the outer lip they extend farther up than elsewhere. There is an indistinct broad variceal thickening behind the outer lip. The small aperture has several weak lip-teeth.

Length 11, diam. 4.25 mm., length of aperture 5 mm.; whorls about 9. Ten ribs on the last whorl.

Somewhat smaller specimens in the same lot have 13, and an immature shell as many as 15 ribs on the last whorl. This species is in or

close to the ancestral stock of *A. avara*. Two Pliocene forms have features possibly derived from this Oligocene form, combined with various diverse characters: *A. avara caloosaensis* Dall, in the Floridian Stage, is more robust than *A. fugax*, the number of sculptured whorls is greater and the suture specially modified. *A. camax* Dall, from a slightly later stage, and even more like *A. fugax*, differs by having but "two smooth and eight reticulated whorls," and the spiral sculpture is far more strongly developed.

In both of the Pliocene species there has been acceleration of the sculpture since the Oligocene form, *A. fugax* having about $5\frac{1}{2}$ smooth and 3 to $3\frac{1}{2}$ sculptured whorls. In various other Pliocene and recent forms of the same stock, however, there has been retardation of longitudinal sculpture, which first appears on the last whorl.

Anachis styliola Dall is a form superficially similar to *A. fugax*, but unlike it in the important feature of having a large, bulbous embryonic shell.

***Strombina mira** Dall.

S. mira Dall, Proc. U. S. Nat. Mus., XIX, p. 312, Pl. 29, fig. 7.

Oligocene marl, near Gatun (Rowell, Hill).

Strombina lessepsiana n. sp. Pl. XXV, figs. 11, 12.

A species closely related to *S. cyphonotus* and *S. prisma*, but more slender than either; fusiform. Spire when perfect of fully 11 whorls, the suture distinctly, though not conspicuously *channelled*, ascending at the end less than in the other species. Last whorl subtriangular in transverse section, having a strongly oblique node on the left side, a low dorsal hump near the suture, and marked with several sharp wrinkles, and behind the outer lip a strong varix preceded and followed by a concavity. At the base there are strong spiral grooves, 11 to 15 in number. Under the lens very weak traces of spiral sculpture may be seen on the almost smooth later whorls. Aperture as in *S. prisma*, but with the canal slightly longer.

Length 27.0, diam. 10.0 mm. (apex entire).

" 22.2, " 9.2 " (apex broken).

" 26.2, " 10.0 " " "

Not uncommon at Gatun. It is even more slender than *S. prisma*,⁵

⁵ We introduce here descriptions of *S. prisma* and *S. cyphonotus* from Johnson and Pilsbry's report on Gabb's Santo Domingo fossils (not yet published), in order to demonstrate the relationships of *S. lessepsiana*.

***Strombina prisma** P. and J., n. sp. Pl. XXV, figs. 9, 10.

"The shell resembles *S. cyphonotus*, but differs by being more fusiform, the obliquely longitudinal hump or node on the left side is stronger, dorsal hump

with a lip-varix of the same type, but the dorsal hump is low and sharply plicate, as in *S. cyphonotus*. Some examples have several sharp, short folds below the suture in the space preceding the dorsal hump.

The status of these Oligocene tricornute forms is not easy to decide. Our object now is merely to indicate the differential features of the several forms.

MURICIDÆ.

Murex messorius Sowb.

The Gatun form agrees well with recent specimens. The species has been found also in the Santo Domingo Oligocene, but reported by Gabb as *M. recurvirostris* (Geol. Santo Domingo, p. 201).

Murex polynematicus n. sp. Pl. XXVI, fig. 1.

This form differs from the recent *M. recurvirostris* and the Oligocene

much more emphatic, high, less plicate. On either side of this hump the surface is more flattened, being especially flattened and sunken in the last third, between the dorsal eminence and the terminal varix. The varix is high and rather narrow, preceded by a concavity, but no ripples. Other features as in *S. cyphonotus*, except that the anterior canal is decidedly longer; lips white.

"Length 26, diam. 10.4 mm.

" 29, " 12.2 "

" 23, " 10.2 "

"This species was among the shells which Gabb had referred to *Strombina gradata*. The longer canal, the narrow lip-varix and the high dorsal hump readily distinguish it from *S. cyphonotus*" (Pilsbry and Johnson).

"*Strombina cyphonotus* P. and J., n. sp. Pl. XXV, figs. 6, 7.

"Shell fusiform, solid, with rather slender, long spire, a little attenuated above, elsewhere with straight, smooth outlines. The tip is broken in all specimens seen, 7 + whorls remaining. These are nearly flat, with the suture impressed by reason of a narrow prominence of the upper edge of each whorl. The penultimate whorl sometimes shows a few slight longitudinal wrinkles. The last whorl is obtusely triangular in transverse section, having a low, oblique hump on the left side of the ventral face, a dorsal hump near the suture sculptured with several longitudinal ripples is preceded by a noticeable concavity, and a massive varix behind the outer lip, rising from and merging gradually into the general convexity of the back. A few ripples, distinct or faint, sculpture the back of the varix. Anteriorly there are about 15 spiral grooves, the upper ones coarse and deep, the lower fine and close. Elsewhere the surface is smooth. The aperture is narrow, lips brown, the inner lip smooth, straight, elevated; the callus within the outer lip bears about 9 small teeth. Anterior canal short and slightly recurved.

"Length 23.1, diam. 11 mm.; length of last whorl, from end of canal to posterior end of the lip-varix 15 mm.

"Other specimens of the type lot measure:

"Length 21.8, diam. 10 mm.

" 23.1, " 10 "

" 21.5, " 11 "

"Oligocene of Santo Domingo, W. M. Gabb.

"This species was incorrectly identified by Gabb (Geology of Santo Domingo, p. 221) with *Columbella gradata* Guppy, a conspicuously different *Strombina* of the Bowden Oligocene. It is related to, and probably an ancestor of, the recent West Coast *Strombina dorsata* (Sowerby), which differs by lacking ripples on the humps, by its seamlike sutures, far weaker basal spirals, etc.

subspecies *domingensis* Gabb by having more numerous spiral threads in the intervals of the major spirals—three or four in each interval. There are six varices on the last one and a half whorls, none on the earlier whorls. The varices are not very large, and not excavated behind. A shoulder spine is present on the last two varices only, and is short and conic. The three intervariceal spaces on the last whorl bear three, two and one folds, respectively. These folds are shorter and higher than in *recurvirostris*. Diameter 38 mm.; length unknown, the anterior canal being broken.

Murex (Phyllonotus) gatunensis. Pl. XXVI, fig. 2.

The shell resembles *M. spinulosa* in general form. Embryonic whorls unknown; subsequent whorls about 6, strongly convex, subangular at the shoulder, the last contracted into a narrow but short anterior canal. Sculpture: on the last whorl seven strong varices, each with a short horizontal spine at the shoulder and about half as wide as the intervals; sharp, narrow, unequal spiral ridges over both varices and intervals. These ridges are unequally spaced, and the concave interstices bear numerous weak spiral striæ. On the penultimate whorl, two ridges are visible below, and two or three above the shoulder-angle. The aperture is triangular-ovate; outer lip has 11 or 12 short, acute teeth on the submarginal internal callus.

Length about 32 or 33 mm. (early whorls wanting), diam. 21 mm.

This species has much resemblance to *Murex spinulosa* Heilprin, but it differs, among other characters, by wanting a basal series of spines.

Typhis alatus Sowerby.

Typhis alatus Sowerby, Journ. Geol. Soc. Lond., VI, p. 48, Pl. 10, fig. 4.

Similar to specimens from the Oligocene of Bowden and Santo Domingo. *Typhis martyria* Dall is a recent survivor of the same group, in the Pacific.

A specimen was lost, which so far as we can remember was probably *Typhis obesus* Gabb.

Typhis gabbi n. sp. Pl. XXVI, fig. 6.

The shell is fusiform, strong, the last whorl having a peculiar sculpture, the surface shrivelled, wrinkled and pitted. The embryo, of nearly two very convex smooth whorls, forms a short style or pillar. Then the diameter enlarges, and a shoulder-angle appears on the latter part of the third whorl. In the middle of the fourth whorl varices and intervariceal tubes appear on the very prominent shoulder, these structures gradually increasing in size to the last whorl, which bears four varices. These are strong and heavy, rounded, somewhat

recurved above the shoulder, where there is a deep pit behind each varix. The tubes are short, midway between the varices, and placed upon low, short folds. The aperture is very small, oval, with a raised rim. Anterior canal closed, bent to the right, having three projecting angles on the left side.

Length 14, diam. 7.3 mm.

Based upon a single quite perfect individual. The sculpture is very characteristic.

STROMBIDÆ.

Strombus gatunensis Toul. Pl. XXVI, figs. 3, 4, 5.

S. gatunensis Toul., Jahrb., p. 698, Pl. XXV, figs. 7, 8.

This species resembles *S. pugilis alatus* Gmel. in having the last whorl smooth except for rather weak spiral cords below the suture and on the base, the shoulder being unarmed. It differs from *alatus* by the neanic whorls, which in *alatus* are subangular, with folds much larger than in *gatunensis*, prominent at the shoulder, fade out above and below. In both species the spire is strongly, evenly striate spirally. In *S. gatunensis* the spire is concave-sided, attenuate and lengthened, the whorls strongly convex, finely and closely plicate longitudinally, the folds extending from suture to suture. On the penultimate and next earlier whorls the folds become obsolete above, remaining short, close nodes on the antepenultimate, larger, separated, subacute tubercles on the penultimate whorl. The last whorl has an obtusely angular shoulder. There are several coarse spiral striæ below the suture, and the lower part is spirally striate. It becomes tumid towards the aperture. The outer lip is somewhat thickened, has a very shallow notch near the lower end, and is weakly wrinkled within, but smooth in the throat.

In one specimen seen there are about two varices on each of the whorls of the attenuated part of the spire. The other shells have none.

Fig. 5. Length 45, diam. 28.5 mm.

Fig. 4. " 50 mm.

In *Strombus bifrons* Sowb., of the Oligocene of Haiti and Jamaica, the folds on the spire are coarser than in *S. gatunensis*; the tubercles persist and are somewhat spiniform on the last whorl, where also the spiral striation is much more strongly developed.

Strombus (?) sp. undet. Pl. XXVI, fig. 7.

An internal cast preserving none of the shell is referable to this genus or possibly to *Orthaulax*. It is peculiar in having an erect flange on one side of the last whorl at the suture, indicating such an ascending lobe in the sutural region as characterizes *Orthaulax gabbi* Dall.

AQUILLIDÆ.

Distorsio gatunensis Toul. Pl. XXVI, fig. 8.

Distorsio (Distortrix, Persona) gatunensis Toul., Jahrb., p. 700, Pl. 25, fig. 10.

This fine species is well-distinguished from Antillean Oligocene and recent forms by the larger size of its low, naticoid, embryonic shell of $3\frac{1}{2}$ whorls, set somewhat aslant upon the sculptured portion following. It measures 2.25 mm. in diameter. The adult shell figured is 49 mm. long, with $6\frac{1}{2}$ post-embryonic whorls.

Malea camura Guppy.

Malea ringens Conrad, Pacific R. R. Reports, VI, p. 72. Pl. 5, fig. 22 (Gatun.)

Malea camura Guppy, Journ. Geol. Soc. Lond., XXIII, p. 287, Pl. 17, fig. 9.

Several specimens, none perfect, are perhaps referable to this Jamaican and Santo Domingan species, which was described from an imperfect example of the small phase, having about 16 spiral ribs. The Gatun shells are much larger, length about 80 mm., have a longer spire than usual in *M. camura*, and about the same number of ribs. Conrad has given a figure of the Gatun form, showing the characteristic high spire.

Seonsia lævigata (Sowb.).

Cassidaria lævigata Sowb., Journ. Geol. Soc., Lond., VI, p. 47, pl. 10, fig. 2.

An internal cast and an imperfect shell broken from a hard matrix evidently belong to this species. They are somewhat more oval, less inflated above, than the largest examples from Santo Domingo.

Pyrula near papyratia Say.

A broken internal cast was found at Gatun, which shows no characters inconsistent with the recent species, yet is not perfect enough for positive identification.

CYPRÆIDÆ.

Cypræa henikeni Sowb., var. Pl. XXVI, figs. 9, 10.

Cypræa henkeri Sowb., Journ. Geol. Soc. Lond., VI, p. 45, Pl. 9, fig. 3.

The typical *C. henikeni* from Santo Domingo has two well-developed callous tubercles on the posterior part of the back, but in some shells these are low or wanting. The sides, posteriorly, are sometimes coarsely corrugated. In the specimens from Gatun there is no trace of the dorsal nodes; the callus has several corrugations on each side of the posterior canal, and lower ones may be felt along the sides. The aperture is like that of Santo Domingo *C. henikeni*, except that the teeth are more compressed and longer. In a specimen 42.5 mm. long there are 15 teeth on the inner, 19 on the outer lip. Specimens retaining part of the color are ochraceous with orange streaks, arranged as in the recent *C. mus*.

Length of figured specimen 42.5, width 31.6, height 23.2 mm. A larger fragment has an outer lip about 55 mm. long.

CERITHIIDÆ.

Bittium nugatorium n. sp. Fig. 1.

The shell is slender, diameter about one-third the length. Embryonic shell conic, of $3\frac{1}{2}$ smooth convex whorls. Subsequent whorls about $6\frac{1}{2}$, convex, with well-impressed suture; they have three narrow spiral cords, increasing to four on the last two whorls, by the addition of a subsutural thread. These are intersected by narrow, slightly flexuous longitudinal ribs, forming a lattice work enclosing square pits. On the last whorl five spirals form this lattice; and there are five smooth spirals without longitudinal ribs on the base. There is a rounded varix on the last whorl. Aperture not perfect. There is a slight anterior channel.

Length 3.6, diam. 1.2 mm.

This species is similar to *Cerithium collinsii* Gabb, from Limon, Costa Rica, in form, but differs by having more embryonic whorls, and three spirals on the whorls of the spire; moreover, the base has five strong spiral cords.

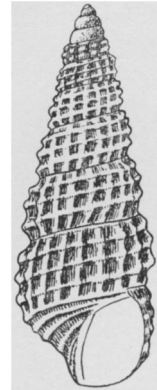


Fig. 1.

TURRITELLIDÆ.

Turritella mimetes n. sp. Pl. XXVII, fig. 1.

The shell resembles *T. variegata* L. in contour, except that the base is flat and the periphery much more strongly angular. Whorls 14+, flat, the lower edge of each projecting a little. In the upper third of the shell, each whorl has 16 fine, even threads, equal, and about equal to their intervals. A submedian thread then becomes larger, and on the later whorls there are many unequal spirals of three or four sizes. The flat base has similar spirals, four or five threads being larger than the other striæ.

Length 64, diam. 18 mm.

This species differs from the recent *T. variegata* by the even and finer striation of the upper whorls, the flat base and strongly angular periphery. It is probably ancestral to the modern species. Some fragments indicate that it reaches a larger size than the nearly perfect type specimen.

Turritella gatunensis Conrad. Pl. XXVII, figs. 4, 5, 9.

Turritella gatunensis Conr., Pacific R. R. Rep., VI, p. 72, Pl. 5, fig. 20.

Dall, Trans. Wagner Inst., III, p. 310, Pl. 17, fig. 10.

Turritella conradi Toulou, Jahrb., p. 694, Pl. 25, fig. 4.

Not *Turritella gatunensis* Conrad, Gabb, Journ. A. N. S. Phila., VIII, p. 342, Pl. 44, figs. 10, 10a (= *T. tristis*.⁶)

This fine species stands close to *T. planigyrate* Guppy, but differs from it by having the upper part of each whorl much more excavated or contracted. Dall's figure, cited above, is not very characteristic of the typical *gatunensis*, and Gabb's figures of the form from the black shale of Oronli Creek, Talamanca, Costa Rica, represent a different species.⁶ The Pliocene *T. subannulata* Dall seems to be related to *T. gatunensis*.

Turritella uvasana Conr., from the Californian Eocene, is not very closely related to *T. gatunensis*, the spiral threads being subequal, and the upper part of the whorls not nearly so much excavated as in the Panamic species. *T. uvasana* is much nearer *T. tristis* in sculpture, but on comparing specimens it is seen that *uvasana* has many more spirals, longer and less convex whorls.

T. gatunensis has been reported from Vicksburg Eocene of Florida and from the Oligocene of Ballast Point (Dall, l.c.). It belongs to a type widely spread in Tertiary and recent faunas.

Turritella altilira Conrad. Pl. XXVII, figs. 2, 3.

Turritella altilira Conr., Pacific R. R. Reports, VI, p. 72, Pl. 5, fig. 19 (Gatun).

Not *Turritella altilirata* Conrad, Gabb, Journ. A. N. S. Phila., VIII, p. 341 Pl. 44, figs. 9, 9a (Sapote, Costa Rica).

Turritella gabbi Toulou, Jahrb., p. 695, Pl. 25, fig. 5 (Gatun).

This magnificent *Turritella* was rather rudely figured by Conrad. It is a common and characteristic species of the Gatun beds. It tapers slowly and, judging from the broken specimens seen, must attain a length of upwards of 100 mm., with a basal diameter of 18 mm., and probably over 25 whorls.

Each whorl bears two very high spiral ribs, crenulated at their summits, the lower rib narrow, the upper wider, usually but not always double at the ridge, or with a lower cord below the main one. The deep concavity between the ridges has sculpture of several unequal spiral cords, more or less crenulated; and the whole surface, when

⁶ *Turritella tristis* n. sp. A long, slowly tapering shell with strongly convex whorls, the intermediate and lower ones with sculpture of five sharp, strong spiral cords, much narrower than their concave, spirally striate intervals. The largest fragment has 9 whorls in a length of 30 mm., the last whorl about 9 mm. in diameter. Gabb has figured this in his Pl. 44, fig. 10. Others are larger, diameter about 15 mm. The interstitial striae are not very well-preserved, but are visible in places. Black shale bed, Oronli Creek, Talamanca.

most perfect, has a very fine spiral striation. The last whorl has a third rib, subperipheral in position, the base below it somewhat convex, marked with some radial striæ and lamellæ.

On the early whorls the spiral ribs are less prominent and the interstitial beaded cords rather better developed. The embryonic and early neanic whorls are unknown.

T. tornata Guppy, known to us by a series collected by Gabb in Santo Domingo, is very closely related to *T. altilira*, but it differs constantly, in a considerable series seen, by the far less prominent spiral ribs. Whether this difference is to be regarded as specific or as subspecific is not a matter of great importance. The Pliocene *T. terebriformis* Dall may be a descendant of the *tornata* stock.

Gabb figured an allied form from the Miocene (?) of Sapote, Costa Rica, as "*Turritella altilirata* Conrad." This name is either a mistake or an emendation of Conrad's *altilira*; but the specimens are clearly not that species. We propose to call Gabb's form *Turritella sapotensis*, n. sp. (Pl. 27, fig. 10). Each whorl has a strong, compressed spiral rib at the lower third, obliquely crenulated at its summit, as in *T. altilira*. Above this rib the surface is a little convex, and bears about five unequal spiral cords, crenulated and very low. The upper two of these cords correspond in position with the upper spiral rib in *T. altilira*. There is also a low cord above the suture. The broken shell figured (which also served for Gabb's Pl. 44, fig. 9a) measures 29 mm. long, 15 mm. in greatest diameter, and consists of somewhat over 3 whorls.

Gabb's figure 9 misrepresents another fragmentary shell, which, from the hard matrix which partly envelopes it, was evidently found with *T. sapotensis*. So far as visible, it very closely resembles *T. tornata* from Santo Domingo. It is clearly not *T. altilira*, nor do we think it a younger stage of *T. sapotensis*, though such may possibly prove to be the case.

The age of the Sapote bed which furnished Gabb's fossils is uncertain. *Clementia dariena* (Conr.) is the only species known to be common to this and the Gatun bed. *Turritella* is an excellent index of small divisions in the Tertiary; *T. sapotensis* is apparently a derivative from *T. altilira*; and so far as that theory is of any value, may indicate that the Sapote bed is later than the Gatun, perhaps Miocene.

VERMETIDÆ.

Petalococonchus domingensis Sowb.

P. domingensis Sowb., Journ. Geol. Soc. Lond., VI, p. 51, Pl. 10, fig. 9.

An internal cast apparently of this species.

SOLARIIDÆ.

Solarium granulatum gatunensis Toula.

S. gatunense Toula, Jahrb., p. 692, Pl. 25, fig. 3.

This form is more depressed than *S. granulatum* or its ancestor *S. quadriseriatum* Sowb., but with sculpture closely resembling both, and especially the form of *granulatum* found in the Bowden Oligocene. It differs from all of the above-named forms by lacking a small thread in the intervals immediately above and below the peripheral cord. The Gatun shell is probably, therefore, a lateral branch from the *quadriseriatum granulatum* stock.

NATICIDÆ.

Natica guppyana Toula.

Natica guppyana Toula, Jahrb., p. 696, Pl. 25, fig. 6.

Closely related to *N. rugosa* Gmel., but adult shells are larger, with the grooves obsolete in the middle of the last whorl.

Natica (?) sp. undet. Pl. XXVII, figs. 6, 7.

Internal cast of a species having about the size and contour of the small southern race of *P. duplicata* (Say). Diameter 40 mm.

Polinices subclausa (Sowb.).

Natica subclausa Sowb., Journ. Geol. Soc. Lond., VI, p. 51 (Santo Domingo).

***Lupia perovato** Conrad.

Dall in Hill, Bull. M. C. Z., XXVIII, p. 273.

Vamos á Vamos beds (Hill). Cf. *Amaura guppyi* Gabb.

Sigaretus gatunensis Toula.

Sigaretus (*Lupia* Conrad) *gatunensis* Toula, Jahrb., p. 697, Pl. 28, fig. 3.

A form related to *S. perspectivus* Say.

CAPULIDÆ.

***Capulus** (?) *gatunensis* Toula.

Jahrb., p. 692, Pl. 25, figs. 1, 2.

Possibly identical with the *Cheilea* described below, but if so the generic characters have been overlooked by Toula. It differs by the oblong shape and more nearly central apex.

CALYPTRÆIDÆ.

Crepidula plana Say.

Several specimens occurred in the apertures of other gastropods.

Cheilea prince-tonia n. sp. Fig. 2.

A small species, circular, conic with apex curved in a minute hook; front slope somewhat convex, posterior slope nearly straight; surface with sculpture of fine growth-lines and a few wide, low, irregular

circular waves, and excessively fine, close radial striæ. Internal process narrow and slightly asymmetrical at its insertion.

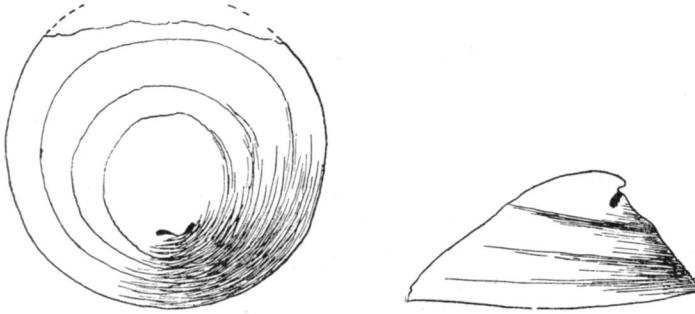


Fig. 2.—*Cheilea princetonia*, dorsal and lateral views of internal cast.

Width 8.8, alt. 3.5 mm.

The type is an internal cast and external mould of the same individual, in a hard matrix. The radial striation is finer than in the recent Antillean *C. equestris* of the same size. *C. varia* (Brod.) of the Pacific coast is apparently more nearly related to the Isthmian form.

The type is No. 5,516 of the Princeton University museum, collected by Mr. Ward H. Farrington, 1908.

NUCULIDÆ.

Nucula (*Acila*) *isthmica* n. sp. Pl. XXVII, figs. 11, 12.

The shell is trigonal with the upper margin anterior to the beaks, and the basal margin strongly convex, the posterior margin shortest and straight; posterior angle rather acute, the anterior rounded off, beaks moderately prominent, opisthocelous, at the posterior third of the length; no lunule. Externally an angle, strong but not acute, runs from the beak to the posterior angle, and a depression or concavity of the outer face accompanies it. Elsewhere the outer face is strongly convex. The flat, truncate, posterior area has a sculpture of arcuate ribs, divaricating at the angle from those of the outer face, and terminating at right angles with the posterior end. The dorsal area anterior to the beaks has a corrugation composed of short ribs which run almost transversely to the long axis of the shell. The rest of the surface has close radial sculpture of riblets which diverge V-like from a median line. These riblets are a little irregular, in places slightly tuberculiferous; they are closer and a trifle narrower near the posterior concavity, becoming perceptibly more spaced anteriorly, where the intervals are a little wider, crossed by irregular, fine, raised

striae. At the basal margin there are several more ribs in the posterior than in the anterior series. Inside there are about 18 teeth in front of the beaks, about 7 behind them. The angle of the hinge line at the beaks is obviously greater than a right angle.

Length 18, alt. 13, diam. 9.5 mm.

Described from a right and a left valve, the latter being figured. It is clearly distinct from *N. decisa* Conrad and *N. cordata* Dall. of the Pacific slope Miocene,⁸ and the recent Pacific *N. castrensis* Hinds.

LEDIDÆ.

Leda balboæ n. sp. Pl. XXVII, fig. 8.

The shell is rather thin, plump, with small submedian, closely adjacent and recurved beaks; pointed posterior and rounded anterior end, and arcuate base, which is less convex posteriorly. The upper margin is slightly concave behind and convex before the beaks. No lunule. Posterior dorsal area lanceolate, concave, defined by an acute carina running to the rostrum, sculptured with straight radial riblets. The rest of the valve has concentric ribs, which are slightly more abrupt on the upper side. In the middle of the valve in 5 mm. next the basal margin there are about 13 riblets. The hinge-line is rather narrow, armed with angular or V-shaped teeth, of which there are 18 behind and 28 in front of the beaks.

Length 22.3, alt. 12.0, diam. 10.0 mm. (type).

“ 19.0, “ 11.3, “ 9.6 “

Known from two right valves. It has much resemblance to the recent Panamic *L. agapea* Dall in contour, but differs by the acute ridge bounding the dorsal posterior area and various other details.

Leda coelata Hinds closely resembles *L. balboæ*, but it differs by having a distinct lunule, which is not present in the Gatun species.

ARCIDÆ.

Arca dariensis n. sp. Pl. XXII, fig. 10.

The shell is long (the alt. six-tenths of the length), basal and upper margins subparallel, beaks small, at the anterior two-sevenths of the length. Valves not quite equal, the left slightly surpassing the other along the basal margin. Sculpture of about 31 radial ribs. In the median part of the valves these ribs are narrower than their intervals. In the left valve the ribs are closely nodulous in the lower part, very shortly scaly near the beaks. Towards the two ends the ribs widen and become divided by a median groove, on both sides of which it

⁸ *Trans. Wagner Inst.*, III, p. 573, Pl. 40.

becomes nodulose, and the intervals are crossed by their lamellæ. In the right valve the ribs are smooth in the middle field, the intervals concave, with concentric lamellæ towards the beaks. At both ends the ribs are wider and divided by a groove, as in the other valve. In both valves the anterior ribs have a shallow sulcus, the posterior ones a distinct narrow furrow. The ligament area is narrow, lanceolate, marked with two or three grooves diverging at a wide angle. The teeth are very fine and close, about 70 in a shell 36 mm. long. Interior radially striate, the margin crenulate as usual.

Length 36.0, alt. 20, diam. 18.2 mm.

“ 31.8, “ 18, “ 13.5 “

This is an abundant Ark in the Gatun bed. It is well-characterized by the rather narrow shape, grooved posterior and shallowly sulcate anterior ribs, while the ribs of the median part are simple in the right, granulous in the left valve.

Glycymeris carbasina n. sp. Pl. XXVIII, fig. 9.

Shell of the usual subcircular shape, solid, equilateral, with slightly prosogyrate beaks, scarcely separated by the very narrow ligament-area. Sculpture of many very low radial ribs equal to the intervals, with over the whole a minute sculpture of radial cut by equal concentric striæ, forming a regular granulation by their intersection. On each rib (to the middle of the interval) there are five or six radial granule-threads. The antero-dorsal and postero-dorsal areas have no major ribs, but there are fine radial riblets, the intervals of which, being crossed by the concentric striæ, appear to have a single series of punctures in each. The hinge is rather wide. Tooth-row of 10.12 teeth meeting V-like in the middle, where they are invaded by the ligamental area in the largest specimen seen. Inner margins of the valves crenulate throughout, the “teeth” of the basal portion very deeply cut, narrow, with a concavity in each.

Length 18, alt. 16, semidiam. 5 mm.; 66 crenulations in the margin, hinge teeth 10.11.

Very closely related to *G. jamaicensis* Dall, of the Bowden Oligocene, but that has much smaller, more numerous hinge-teeth in shells of the same size, the anterior contour is more irregular, and the fluting of the basal margin is far less deep. The external sculpture is practically identical in the two forms. The recent Antillean *G. lineata* (Rve.) is extremely close to *G. carbasina*, but in the latter the marginal fluting is far more emphatic. We do not know that the fossil form ever attains nearly the size of *G. lineata*, of which it is probably a direct ancestor.

Two other specimens measure as follows:

Length 14.9, alt. 14.8, semidiam. 4.9 mm.; hinge-teeth 8.9.

“ 14.0, “ 12.5, “ 3.9 “ “ “ 7.9.

Glycymeris canalis n. sp. Pl. XXVIII, fig. 10.

The subcircular shell is a little higher than long, solid, equilateral, with nearly straight, contiguous beaks, the ligamental area being extremely narrow and short. Sculpture of 33 strong, rounded ribs, separated by linear grooves, and obsoletely marked with rather regular concentric growth-striæ. Tooth-row strongly angulated in the middle, with 10 teeth on each side. Inner margin crenulated with about 20 strong “teeth,” the upper margins not crenulated.

Length 14.5, alt. 15.1, semidiam. 4.6 mm.

Described from several valves, on which we count 30, 31, 32 and 33 ribs. This species has a close resemblance to *G. pectinata* (Gmel.) of the Antillean fauna, which differs by having wider sulci between the ribs, and by having an area of smaller ribs on the anterior end, while in *canalis* they decrease gradually in size.

Glycymeris acuticostata Sowb.

Pectunculus acuticostatus Sowb., Journ. Geol. Soc. Lond., VI, 1849, p. 53, Pl. 10, fig. 13 (Santo Domingo).

Typical, agreeing with Santo Domingo and Jamaican specimens.

PECTINIDÆ.

Pecten (Æquipecten) effossus n. sp. Pl. XXVIII, figs. 4, 6.

An orbicular, equilateral, compressed shell, resembling *P. scissuratus* Dall. The length and diameter are nearly equal, the ears subequal, the left valve nearly flat, the right one more convex. A left valve has 17 ribs, as wide as the slightly concave intervals. Each rib has the shape of an inverted V, but with rounded ridge, and a thin longitudinal lamella in the middle of each lateral slope, these lamellæ define furrows which terminate in incisions at the edge. The whole surface is finely sculptured with delicate concentric threads, subregularly and not closely spaced. These threads are arched downward in the intervals. Ears marked with several narrow radial riblets and concentric growth-threads. Length 11.2, alt. 11 mm. The right valve of a large shell, alt. about 19 mm., has similar sculpture, except that the ribs are larger. The interior is deeply furrowed in both valves.

The specimens of *P. scissuratus* in Gabb's Santo Domingo collection (Pl. 28, figs. 2, 5; alt. 27, width 27.5 mm.) differ from the above-described form by having the concentric threads crowded and crimped in the intercostal spaces and by having much better developed lam-

ellæ across the furrows on the ribs. They have been compared with the types of the species by Dr. W. H. Dall. Fig. 2 measures, alt. 27, width 27.8 mm.

Pecten gatunensis Toula.

Pecten (Flabellipecten) gatunensis Toula, Jahrb., p. 711, Pl. 26, fig. 2.

The fragmentary specimens taken add nothing to Toula's account.

Pecten (Plagioctenium) operculariformis Toula.

Pecten (Æquipecten?) operculariformis Toula, Jahrb., p. 712, Pl. 26, fig. 3.

The ribs are narrower and have steeper slopes than in the related recent *P. nucleus*. *P. excentricus* Gabb is a closely related, yet apparently distinct form, from Santo Domingo.

***Pecten levicostatus** Toula.

Pecten levicostatus Toula, Jahrb., p. 713, Pl. 26, figs. 4 (5, 6).

Pecten thetidis Sowb. and *Janira soror* Gabb have been identified by Gabb from Gatun (*Journ. A. N. S. Phila.*, VIII, 346, 347).

***Pecten (Amusium) lyonii** Gabb.

Pleuronectia lyonii Gabb, *Journ. A. N. S. Phila.*, VIII, p. 347 (Gatun specimens).

Pecten (Amusium) cf. mortoni Ravenel, Toula, Jahrb., p. 714, Pl. 26, figs. 8, 9.

This form is not present in our material. Gabb reported it from Gatun, and Toula has figured specimens which have the appearance of the Costa Rican species, the types of which are before us.

Pecten (Amusium) toulæ n. sp. Pl. XXVIII, fig. 7.

Pecten (Amusium) gatunensis Toula, Jahrb., p. 716, Pl. 26, fig. 10. Not *Pecten gatunensis* Toula, *t. c.*, p. 711.

The shell is smooth, thin and flat, equilateral, closely resembling *P. lyonii* Gabb, of Sapote, Costa Rica (probably Miocene), and *P. papyracea* Gabb, of the Santo Domingan Oligocene. The surface is marked with narrow, sharply defined gray rays on a white ground, the rays less than half as wide as the intervals, subequal in the median part, much narrower at the sides, where they gradually fade out, and about 17 in number. Ears broad, subequal, marked with close, fine growth-lines, more distinct than on the disk. Interior smooth, so far as seen, but the marginal region, where ribs are developed in related forms, is wanting in the specimen. Greatest breadth of the broken specimen figured 48 mm. It attains a much greater size.

In *P. lyonii* the gray rays are wider, when visible, and the spaces between them are slightly convex; the interior has coarse radial ribs, but none are visible in *P. toulæ* where the inside is exposed, at the lower margin of the broken shell. *P. papyracea* has fine internal ribs in pairs.

Toula has figured and described this species, but by oversight he used a specific name already employed on a previous page of the same paper.

OSTREIDÆ.

Ostrea gatumensis n. sp. Pl. XXIX, figs. 1, 2.

Ostrea spec. ind. and *Ostrea aff. vespertina* Conr., Toula, Jahrb., p. 710. Pl. 26, fig. 1; Pl. 28, fig. 14.

A short oval oyster, the convex valve with coarsely, radially corrugated exterior, the rugæ rarely divaricating, and with a few decumbent spines. The rather short beak is bent at an angle of about 45 degrees with the long axis of the shell. Inside there is a rather short ligament area, the wide valve-margin adjacent to it being sculptured with strong, close, transverse, irregular wrinkles. The margins are elsewhere simple. Cavity of the valve not deep, and not in the least excavating the beak.

Length 100, width 72 mm.

Toula (*l. c.*) mentions an oyster near *vespertina* Conrad which is probably the young of this species and of his undetermined *Ostrea*.

The interior reminds one somewhat of *O. iridescens* Brod., but that has a deep excavation under the beak, among other differences. It stands extremely close to the recent Indo-Pacific *O. hyotis* (L.).

Part of a valve of a very narrow, strongly convex and very peculiar oyster was also found at Gatun.

CARDIIDÆ

Cardium (Trachycardium) striatum n. sp. Pl. XXVIII, fig. 11.

Cardium spec., vielleicht eine neue Art, Toula, Jahrb., p. 721, Pl. 27, fig. 5; Pl. 28, fig. 15a, b.

The shell is rather thick, very plump, much higher than long, nearly equilateral, the posterior end a little straightened. Beaks median, the incurved tip concealed by the reflexed hinge-margin. Sculpture of 30 radial ribs. At the two ends these ribs bear strongly projecting, drop-shaped tubercles. In the median part of the valve the ribs lean posteriorly, and have a narrow tuberculate cord superposed on the posterior side of each, the tubercles elongated parallel to the cord in the median ribs, oblique or twisted on it, on the lateral ribs. The interstices are not very deep at the ends, but in the median moiety of the valve they are narrow and very deeply cut, overhung by the high side of the rib. The middle of each rib, anterior of the tuberculate ridge, bears one or several low cords, and the anterior slope has some fine, irregular, transverse striæ. Teeth strong, margin deeply fluted

and crenulate, the crenulations narrow and deep on the posterior margin, triangular in the basal margin, very shallow at the anterior margin.

Length 29.5, width 24, semidiameter 12 mm.; 30 ribs.

“ 31.0, “ 25, “ 13 “ ; 29 “

This species is closely related to the recent West Coast *Cardium belcheri* Brod., which has ribs of the same peculiar, asymmetrical character. In the Gatun shell there are many more ribs, and the tubercles upon them are shorter and blunt, while in *C. belcheri* they are more spiniform.

Cardium linguleonis Guppy is proportionately narrower and has more ribs, but seems to be rather close to the Gatun species.

C. stiriatum is, by its complex sculpture, a relatively specialized form; but it is less advanced than the recent *C. belcheri*, which is further evolved by the reduction in number of ribs; a large number being primitive in *Cardium*. *C. stiriatum* may be an ancestor of the recent species.

This species was known to Toulou by hard internal casts, which alone are found in a layer containing mainly bivalves. The largest of several of these casts before us measures, length 26, alt. 33, diam. 26.5 mm.

***Cardium (Trachycardium) dominicanum** Dall.

C. (T.) dominicanum Dall, Trans. Wagner Inst., III, p. 1,082.

Oligocene shale near Gatun.

Cardium (Trachycardium) dominicense Gabb.

C. (T.) dominicense Gabb, Geol. Santo Domingo, p. 25; Journ. A. N. S. Phila., VIII, p. 344 (Gatun and Costa Rica).

Cardium (Trachycardium) gatunense Toulou, Jahrb., K. K. Geol. Reichsanst., 1908, LVIII, p. 720, Pl. 27, fig. 4. Not *Cardium (Fragum) gatunense* Dall, 1900.

Abundant in the Gatun collection we have studied. The specimens agree perfectly with Gabb's type of *C. dominicense*.

Cardium (Lævicardium) serratum L.

Dall, Trans. Wagner Free Inst., III, p. 1110.

The shell seems indistinguishable from those of the Bowden bed and from the recent form. *C. apicinum* Cpr. from the Pacific is closely related.

***Cardium (Lævicardium) dalli** Toulou.

Jahrb., p. 722, Pl. 27, fig. 6.

If really distinct from *C. serratum*, this species will require a new name, *dalli* being in use for a fine Pliocene species.

***Cardium (Fragum) gatunense** Dall.

Trans. Wagner Free Inst., III, p. 1100.

Black shales of Gatun, collected by R. T. Hill. We have not seen this species.

***Cardium (?) newberryanum** Gabb.

C. (Protocardia) newberryanum Gabb, Journ. A. N. S. Phila., VIII, p. 344, Pl. 44, fig. 17.

Gatun (Newberry).

TELLINIDÆ.***Tellina dariena** Conrad.

T. dariena Conr., Pacific R. R. Rep., V, p. 328, Pl. 6, fig. 55.

***Tellina gatunensis** Toula.

T. gatunensis Toula, Jahrb., p. 729, text fig. 10.

***Tellina rowlandi** Toula.

T. rowlandi Toula, Jahrb., p. 728, Pl. 28, fig. 11.

***Tellina lepidota** Dall.

Tellina (Phyllodina) lepidota Dall, Trans. Wagner Free Inst., III, p. 1022, Pl. 46, fig. 18.

Oligocene sandstone at Gatun (Dall).

***Semele sayi** Toula.

S. sayi Toula, Jahrb., p. 730, Pl. 28, fig. 17.

Tellina sp. undet.

Casts of a species resembling *Tellina lævigata* in size and shape. It is distinct from any species recorded by Toula, and apparently not found in the Bowden or Santo Domingo beds.

Tellina sp. undet.

Casts of a species possibly identical with *T. laceridens* Hanley, agreeing closely with that in shape. It is somewhat larger; length 61, alt. 37 mm.

We consider fig. 168 of the *Thesaurus* monograph to be the typical form of *T. laceridens*.

VENERIDÆ.**Chione tegulum** n. sp. Pl. XXVIII, fig. 8.

Shell plump, the altitude almost equal to the length, with prominent prosogyrate beaks near the anterior third. Sculpture of rounded, tilelike radial ribs (their summits 1 mm. apart near the basal margin, in the median part of a shell 19 mm. in alt.); these are interrupted by narrow, concentric, machiolated ridges, curved downwards in the intervals, upward where they cross the radial ribs. There are 26 of the concentric ridges in a shell 19 mm. in altitude. The wide, cordate

lunule has radial lamellæ only, and is defined by a deep groove. The lanceolate escutcheon is concave, with sculpture of smooth raised lines continued from the concentric lamellæ. The basal and anterior valve-margins are crenulated inside, as is also the margin along the lunule.

Length 19.5, alt. 19, semidiameter 8 mm.

This species resembles *C. woodwardi* Guppy, from the Bowden Oligocene, but differs by having a smaller lunule, and in the details of sculpture, as shown in the figure.

Chione sp. undet.

A species resembling *C. woodwardi*, but reaching a length of over 40 mm., occurred as casts retaining very little of the shell.

Chione (Liriphora) ulocyma (Dall).

Trans. Wagner Inst., III, p. 1296, Pl. 42, fig. 5 (Miocene of Alum Bluff, Calhoun County, Fla., etc.).

Venus (*Chione*, *Liriphora*) *ulocyma* Dall, Toul., Jahrb., p. 724, Pl. 25, figs. 20-22.

There seem to be two forms: one agreeing with the type figure of *ulocyma* in having coarse concentric sculpture; the other having much finer, more numerous wrinkles. In the former the beaks appear to be smooth, but possibly as the result of wear. In the finely sculptured form the beaks have about five thin concentric widely spaced laminae, preceding the corrugated stage, such as are described for *C. burnsi* Dall. This race may be called *C. ulocyma holocyma*. In this race, as well as in the coarse form, the radial grooves are very strongly developed.

***Chione (Liriphora) mactropsis** (Conrad)

Grateloupia mactropsis Conrad, Pacific R. R. Rep., V, p. 328, Pl. 6, fig. 54.

Chione (*Liriphora*) *mactropsis* Conr., Dall. Trans. Wagner Inst., III, p. 1294.

Eocene and Oligocene of Isthmus of Darien, Blake; Gatun and Vamos-a-Vamos, Panama Canal, Agassiz. 10.5 K. w. of Colon, Hill (Dall). Chiriqui, Dr. John Evans (Gabb).

Pitar centangulata n. sp.

Pitaria (*Hyphantosoma*) n. sp., Toul., Jahrb., p. 726, Pl. 28, fig. 16.

Cf. *Pitaria* (*Hyphantosoma*) *opisthogrammata* and *floridana* Dall, Trans. Wagner Inst., III, p. 1,267.

This species is closely related, as Toul. has pointed out, to the above-named species of Dall. It differs from *P. floridana* (from the Chipola Oligocene) in the rotund-oval, not "subtrigonal" shape, and in the even rotundity of the valves, without trace of a flattening or sulcus running to the posterior base; but it agrees with *floridana*

in the very fine, markedly zigzag sculpture, there being three to four lines to a millimeter. *P. opisthogrammata*, of the Floridian Pliocene, is a "rounded-quadrate" shell with "the zigzag sculpture nearly obsolete."

Pitar cora n. sp. Pl. XXVIII, fig. 3.

The shell is extremely thin, oval, with prosogyrate beaks at the anterior fourth; rather plump; dorsal margin rather concave in front of, and slightly convex behind, the beaks. Sculpture of fine, nearly even concentric riblets, without radial striation. No defined lunule or escutcheon. Interior unknown, but the valve-margins are smooth inside.

Length 35, alt. 26.5, diam. 18.5 mm.

This species occurred as casts in a hard matrix retaining the shell in places. *P. hilli* Dall is a longer, lower shell.

****Macrocallista maculata*** (L.) (?).

Cytherea (?) (*Meretrix*) *dariena* Conrad, Pacific R. R. Rep., VI, p. 72, Pl. 5, fig. 21.

"Isthmus of Darien." Identified by Gabb and Dall with the above recent species, but the cast figured by Conrad seems to us uncharacteristic.

****Pitar hilli*** Dall.

Pitaria (*Lamelliconcha*) *hilli* Dall, Trans. Wagner Inst., III, p. 1,268, Pl. 54, fig. 7.

Near Gatun.

****Pitar circinata*** (Born).

Venus circinata Born, Mus. Test. Vindobon., p. 61, Pl. 4, fig. 8.

Pitaria (*Lamelliconcha*) *circinata* Born, Dall, Trans. Wagner Inst., III, p. 1269.

Cytherea juncea Guppy, Q. Journ. Geol. Soc. Lond., XXII, p. 582, Pl. 22, fig. 13 (Oligocene of Cumana, Venezuela).

Gatun (Dall). Also recent, on both coasts of Central America. It is a more coarsely, sharply sculptured shell than *P. cora*.

****Callocardia* (*Agriopoma*) *gatunensis*** Dall.

C. (A.) gatunensis Dall, Trans. Wagner Inst., III, p. 1,260, Pl. 54, fig. 1. Toula, Jahrb., p. 723, Pl. 25, fig. 23.

Gatun; Monkey Hill.

****Callocardia gatunensis multiflosa*** Dall.

Dall, *l. c.*, p. 1,261, Pl. 54, fig. 15.

Gatun, with the preceding. Also Ponton, Santo Domingo. We have not seen this species, which should resemble *Pitar cora* rather closely, except as to the lunule.

Another *Callocardia*, undetermined, is recorded by Dall from Vamos-a-Vamos (*t. c.*, p. 1,261).

Clementia dariena (Conrad). Pl. XXVIII, fig. 1.

Meretrix dariena Conrad, Pacific R. R. Rep., V, p. 328, Pl. 6, fig. 55.

Clementia dariena Conr., Gabb, Journ. A. N. S. Phila. (2), VIII, p. 344, Pl. 44, fig. 16. Dall, Trans. Wagner Inst., III, p. 1,235.

Toula, Jahrb., p. 725, Pl. 27, figs. 9, 10.

A common clam in the Gatun Oligocene, also found in the presumably later bed at Sapote, Costa Rica. No nearly related species has been found in the Santo Domingo or Bowden beds.

Cyclinella gatunensis Dall.

C. gatunensis Dall, Trans. Wagner Inst., III, p. 1,285, Pl. 52, fig. 18.

In the best preserved specimens the sculpture of somewhat thread-like concentric lines is about equally strong over the whole valve, except near the beaks. Except for the tenuity of the shell, it might be a *Dosinia*.

MACTRIDÆ.

***Mactra dariensis** Dall.

M. dariensis Dall, Trans. Wagner Inst., III, p. 895.

Vamos-a-Vamos.

CORBULIDÆ.

Corbula gatunensis Toula.

C. gatunensis Toula, Jahrb., p. 733, Pl. 27, fig. 12.

This species attains a larger size than Toula's type, an example measuring, length 26, alt. 22 mm. It is remarkable for the disparity in sculpture between the ribbed neanic and the smooth mature stage.

Corbula sphenia Dall.

Corbula (Cuneocorbula) sphenia Dall, Trans. Wagner Inst., p. 847, Pl. 36, fig. 10 (Chipola River Oligocene).

A single valve agrees fairly well with the account of this species. It has more and narrower concentric ribs than the figure of that species shows, and is larger, length 22.2, alt. 13.5 mm. Probably identical with *C. dominicensis* Gabb, but there are some slight differences.

Corbula sericea Dall.

Corbula (Cuneocorbula) sericea Dall, Trans. Wagner Inst., p. 848, Pl. 6, fig. 8 (Oligocene of Bowden, Jamaica).

A single valve from Gatun is evidently referable to this species.

***Corbula alabamiensis** Lea.

C. alabamiensis Lea, Dall, Trans. Wagner Inst., III, p. 841.

Described from the Alabama Eocene (Claibornian); reported by Dall from the Gatun beds.

***Corbula gregorioi** Cossmann.*C. gregorioi* Cossm., Dall, Trans. Wagner Inst., III, p. 843.

A Claibornian Eocene species reported by Dall from the Gatun beds.

***Corbula heterogenea** Guppy.*C. heterogenea* Guppy, Dall, Trans. Wagner Inst., III, p. 850.

Vamos-a-Vamos (Dall).

***Corbula viminea** Guppy.*C. viminea* Guppy, Dall, Trans. Wagner Inst., III, p. 850.

Vamos-a-Vamos (Dall).

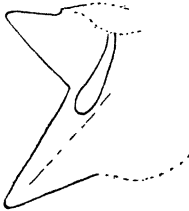
TEREDIDÆ.**Teredo dendrolestes** n. sp. Text fig. 3; Pl. I, fig. 10.

Fig. 3.

The thin-walled tubes are crowded, run with the grain of the wood, as usual, curving outward at the orifice. They have a diameter of about 5 mm., the longest (broken) reaching a length of about 60 mm. The terminus of the tube is hemispherical. It encloses a very delicate shell shaped like the annexed outline figure. There are long apophyses. The exterior of the shell is unknown, being cemented to the calcified tube.

SOLENIDÆ.***Solecurtus gatunensis** Toula.*Solecurtus gatunensis* Toula, Jahrb., p. 732, Pl. 28, fig. 12.***Solecurtus strigillatus** (L.).*Solecurtus (Macha) strigillatus* L., Toula, Jahrb., p. 731, text fig. 11, Pl. 27, fig. 12.***Thracia gatunensis** Toula.*Thracia gatunensis* Toula, Jahrb., p. 757, text fig. 15.**REFERENCE TO PLATES XXII-XXIX.****PLATE XXII.**—Fig. 1.—*Terebra wolfgangi* Toula.Fig. 2.—*Terebra gatunensis* Toula.Figs. 3-6.—*Terebra wolfgangi* Toula.Fig. 7.—*Terebra subsulcifera* n. sp., $\times 2$.Figs. 8, 9.—*Terebra gansapata* n. sp., two views of the type, fig. 8, $\times 5$.Fig. 10.—*Arca dariensis* n. sp.Fig. 11.—*Teredo dendrolestes* n. sp.**PLATE XXIII.**—Fig. 1.—*Conus molis* n. sp.Figs. 2, 3.—*Conus gaza* n. sp. (Santo Domingo).Fig. 4.—*Conus imitator* n. sp.Figs. 5, 6.—*Conus concavitectum* n. sp.Fig. 7.—*Drillia fusinus* n. sp.

- Fig. 8.—*Drillia zooki* n. sp.
 Fig. 9.—*Conus æmulator* n. sp., $\times 2$.
 Figs. 10, 11.—*Drillia isthmica* n. sp.

PLATE XXIV.—Figs. 1, 2.—*Cancellaria dariena trachyostraca* n. subsp.

- Figs. 3, 4.—*Cancellaria dariena* Toula.
 Figs. 5, 6.—*Cancellaria decaptyx* n. sp., two views of the type.
 Fig. 7.—*Mitra*, sp. undet., part of the columella.
 Fig. 8.—*Mitra*, sp. undet., internal cast, No. 5,515, coll. Princeton University.
 Fig. 9.—*Mitra dariensis*, n. sp.
 Fig. 10. *Marginella gatunensis* n. sp.
 Fig. 11.—*Mitra longa* Gabb, Gatun specimen.
 Fig. 12.—*Marginella coniformis* Sowb., var.
 Fig. 13.—*Marginella leander* n. sp.
 Fig. 14.—*Solenosteira dalli* n. sp.

PLATE XXV.—Figs. 1, 2.—*Phos gatunensis* Toula.

- Fig. 3.—*Phos subsemicostatus* n. sp.
 Fig. 4.—*Metula gabbi* n. sp.
 Fig. 5.—*Anachis fugax* n. sp.
 Figs. 6, 7.—*Strombina cyphonotus* P. and J., n. sp., Santo Domingo.
 Fig. 8.—*Metula gabbi* n. sp.
 Figs. 9, 10.—*Strombina prisma* J. and P., n. sp., Santo Domingo.
 Figs. 11, 12.—*Strombina lessepsiana* n. sp.

PLATE XXVI.—Fig. 1.—*Murex polymematicus* n. sp.

- Fig. 2.—*Murex gatunensis* n. sp.
 Fig. 3.—*Strombus gatunensis* Toula.
 Figs. 4, 5.—*Strombus gatunensis* Toula, No. 5,512, coll. Princeton University.
 Fig. 6.—*Typhis gabbi* n. sp.
 Fig. 7.—*Strombus* (?) sp., internal cast.
 Fig. 8.—*Distorsio gatunensis* Toula.
 Figs. 9, 10.—*Cypræa henikeni* Sowb., smoothish var., No. 5,511, Princeton University.

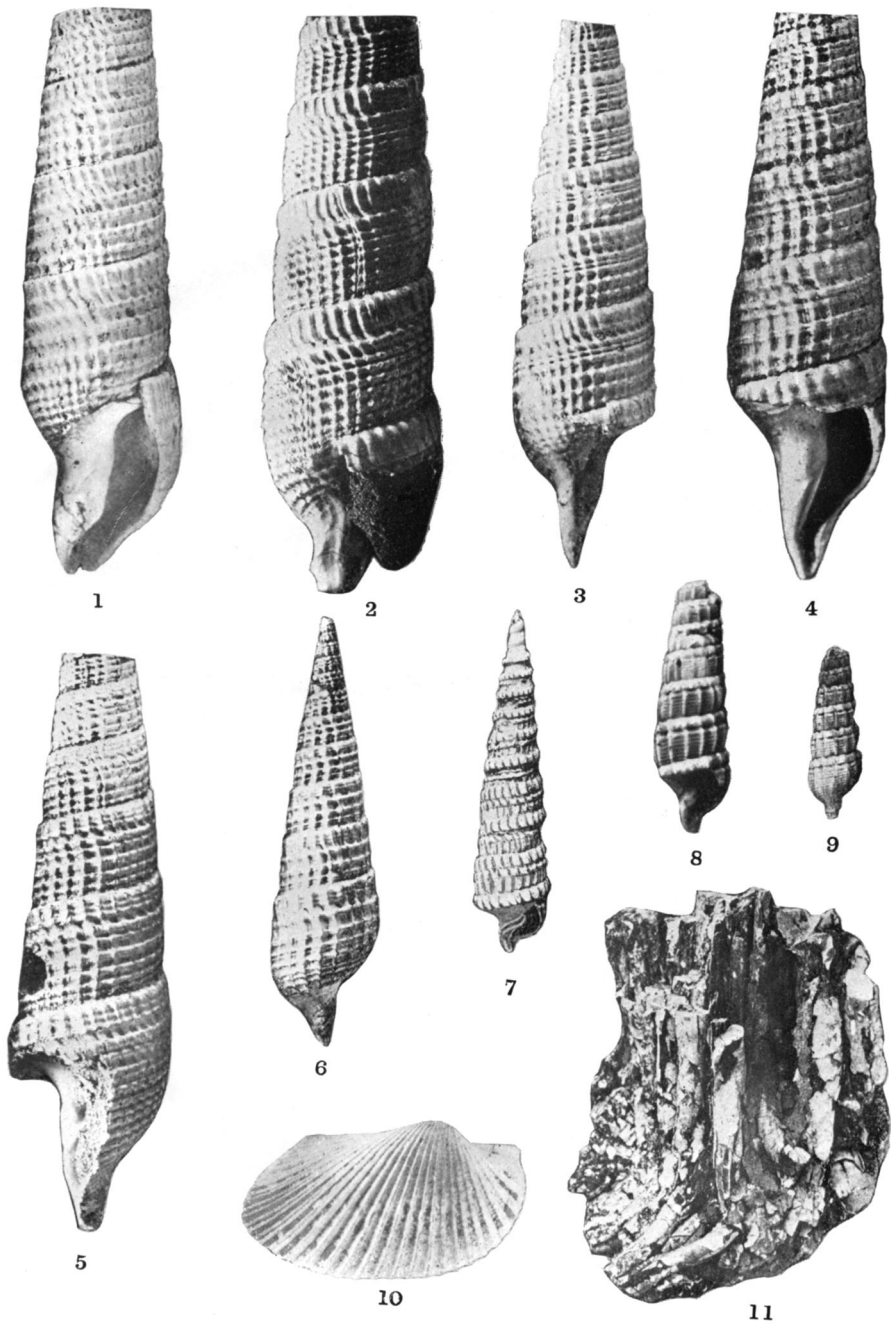
PLATE XXVII.—Fig. 1.—*Turritella mimetes* n. sp.

- Figs. 2, 3.—*Turritella altilira* Conrad.
 Figs. 4, 5.—*Turritella gatunensis* Conrad.
 Figs. 6, 7.—*Natica*, sp. undet. Internal cast.
 Fig. 8.—*Leda balboæ* n. sp.
 Fig. 9.—*Turritella gatunensis* Con. Pseudomorph in calcite.
 Fig. 10.—*Turritella sapotensis* n. sp., Sapote, Costa Rica.
 Figs. 11, 12.—*Nucula (Acila) isthmica* n. sp.

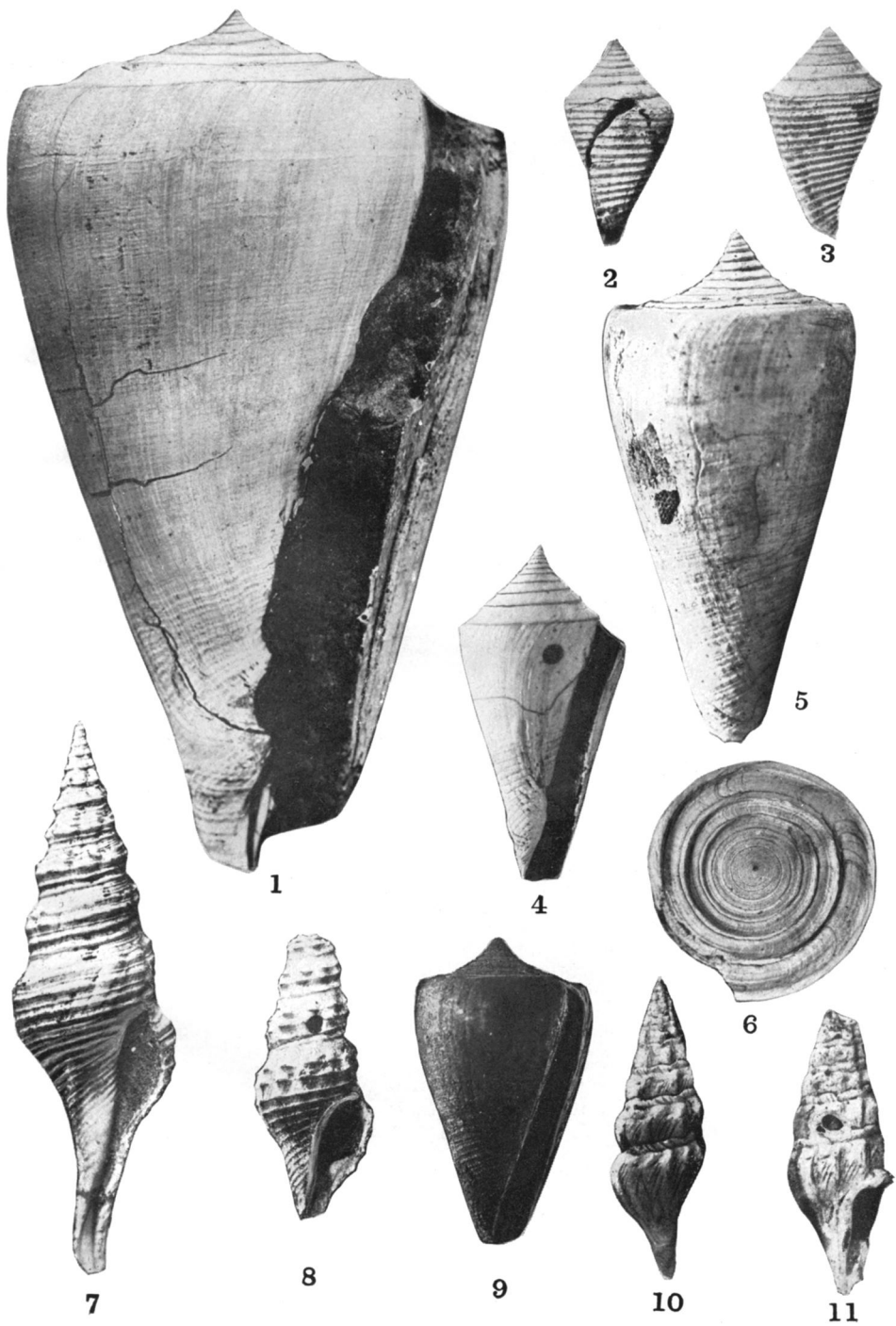
PLATE XXVIII.—Fig. 1.—*Clementia dariensis* Conr.

- Fig. 2.—*Pecten scissuratus* Dall. Typical form from Santo Domingo.
 Fig. 3.—*Pitar cora* n. sp.
 Fig. 4.—*Pecten effossus* n. sp.
 Fig. 5.—*Pecten scissuratus* Dall. Santo Domingo.
 Fig. 6.—*Pecten effossus* n. sp.
 Fig. 7.—*Pecten toulæ* n. sp.
 Fig. 8.—*Chione tegulum* n. sp.
 Fig. 9.—*Glycymeris carbasina* n. sp.
 Fig. 10.—*Glycymeris canalis* n. sp.
 Fig. 11.—*Cardium stiriatum* n. sp.

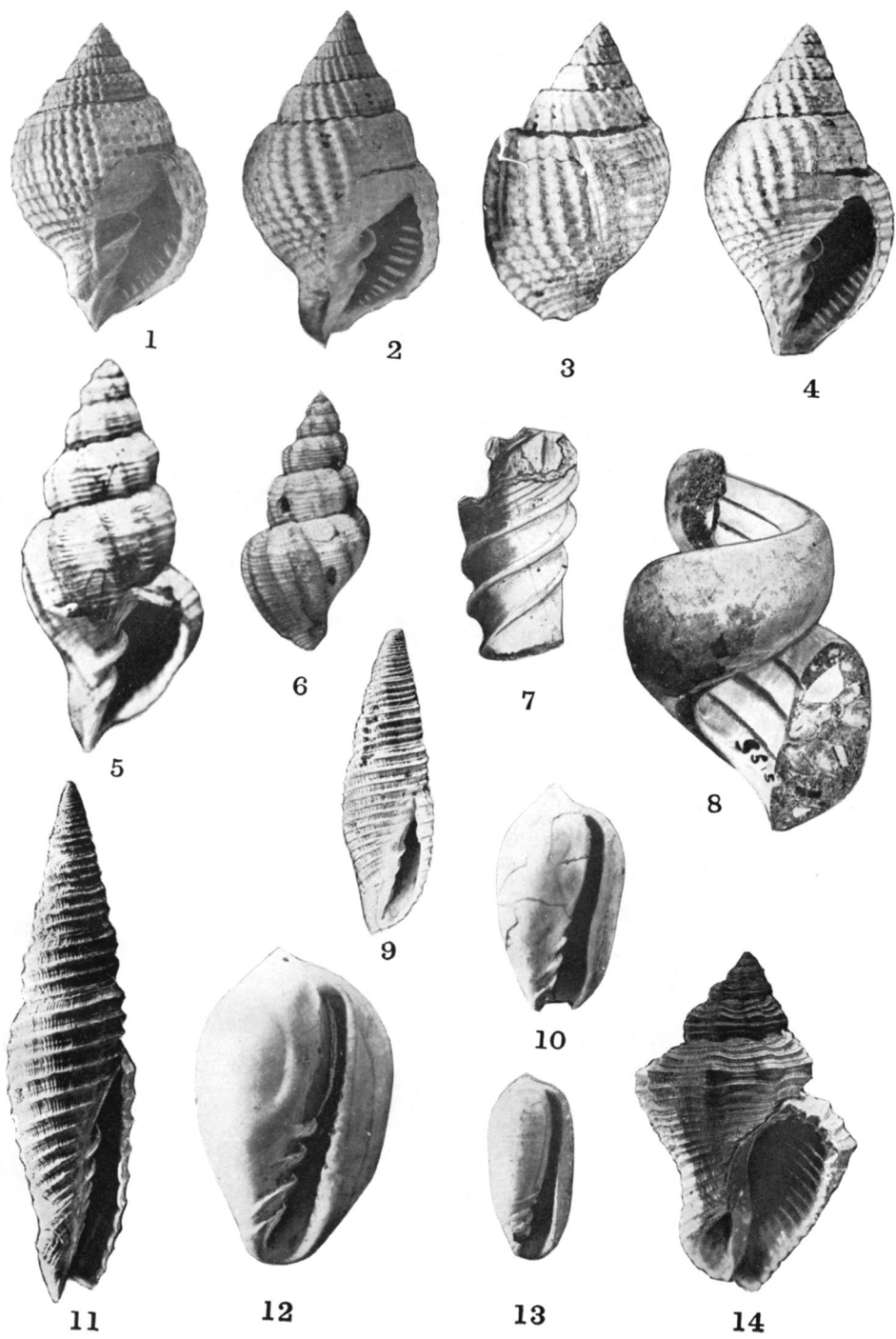
PLATE XXIX.—Figs. 1, 2.—*Ostrea gatunensis* n. sp.



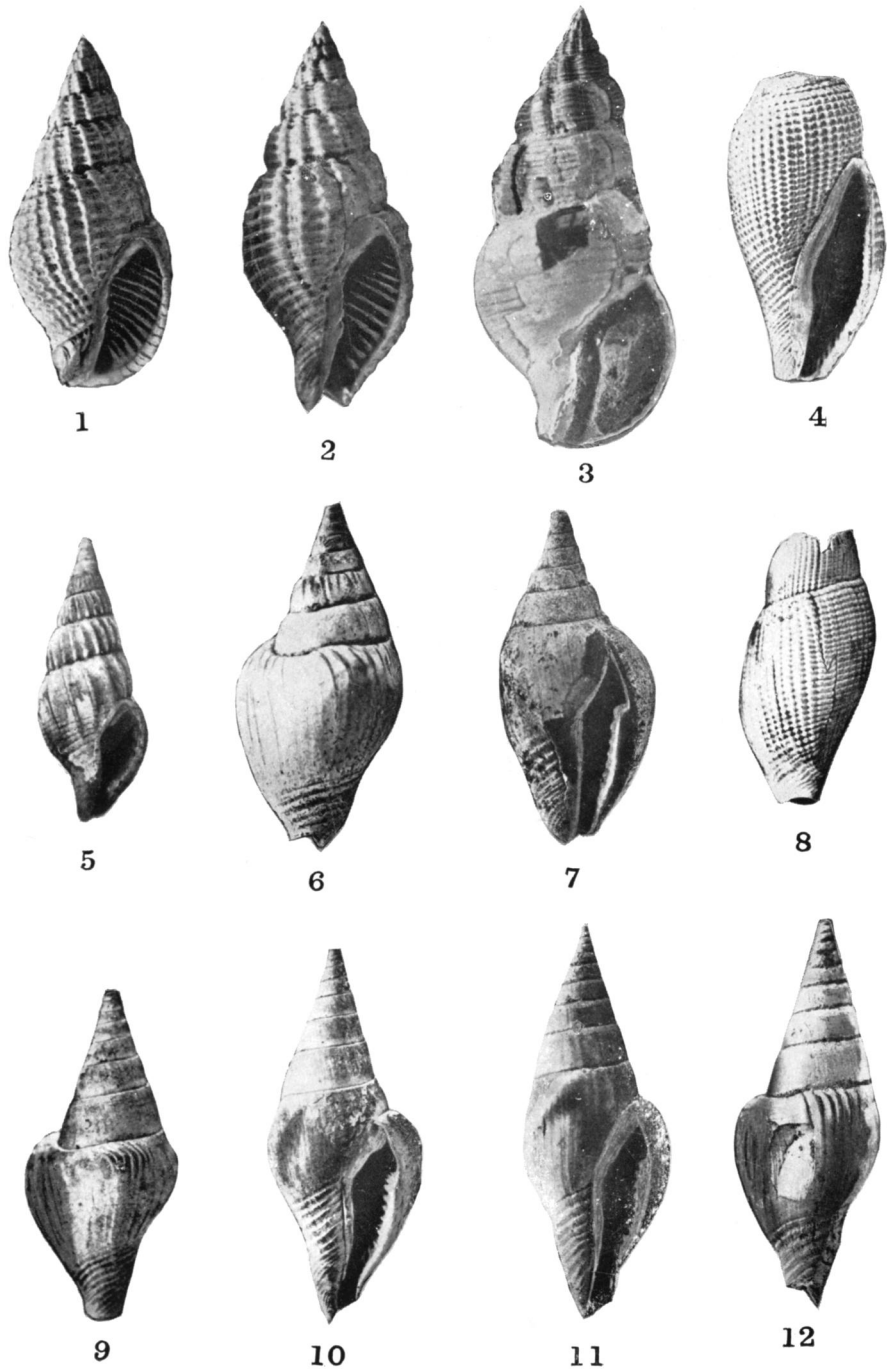
BROWN AND PILSBRY: GATUN FOSSILS.



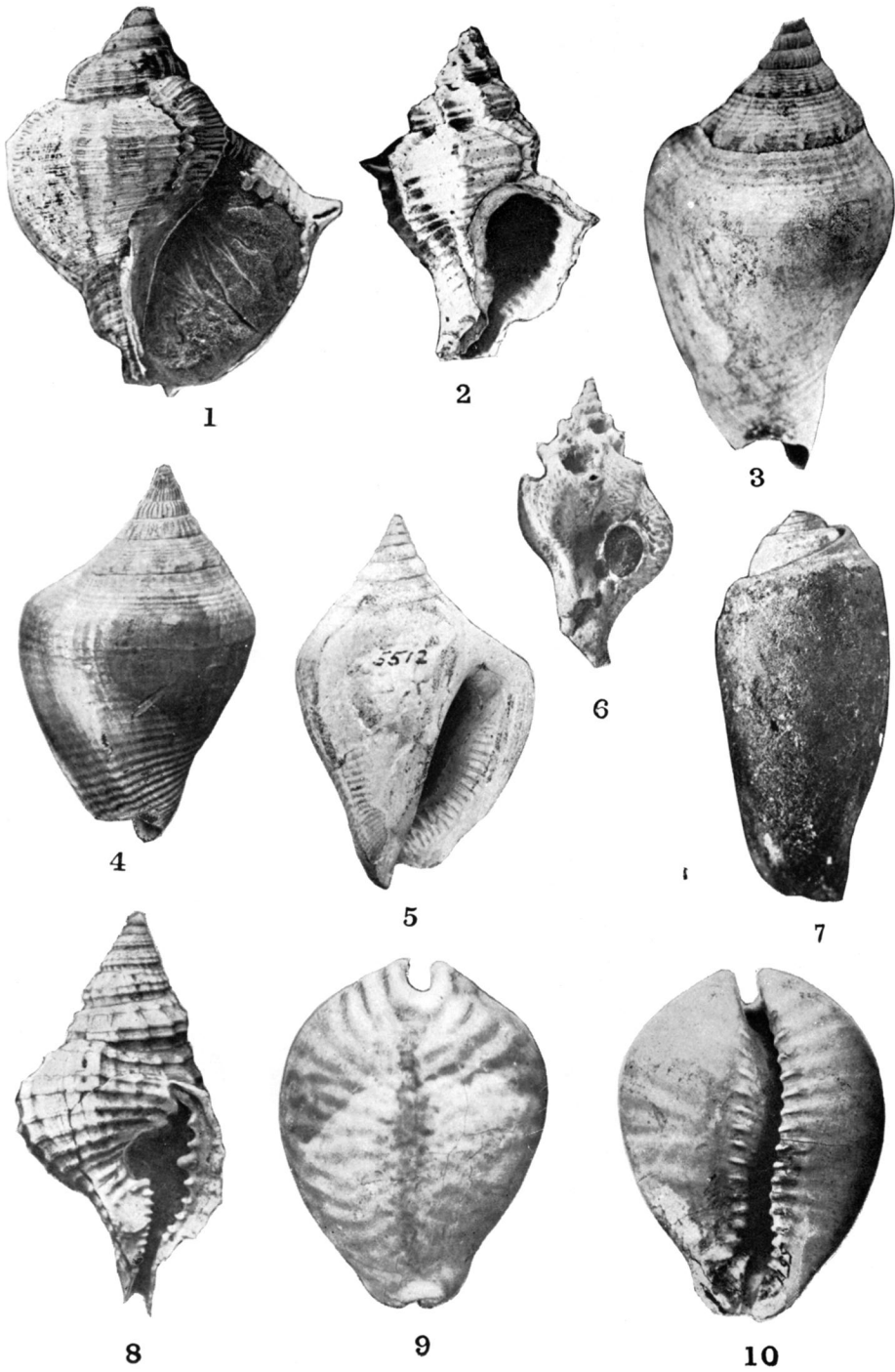
BROWN AND PILSBRY; GATUN FOSSILS.



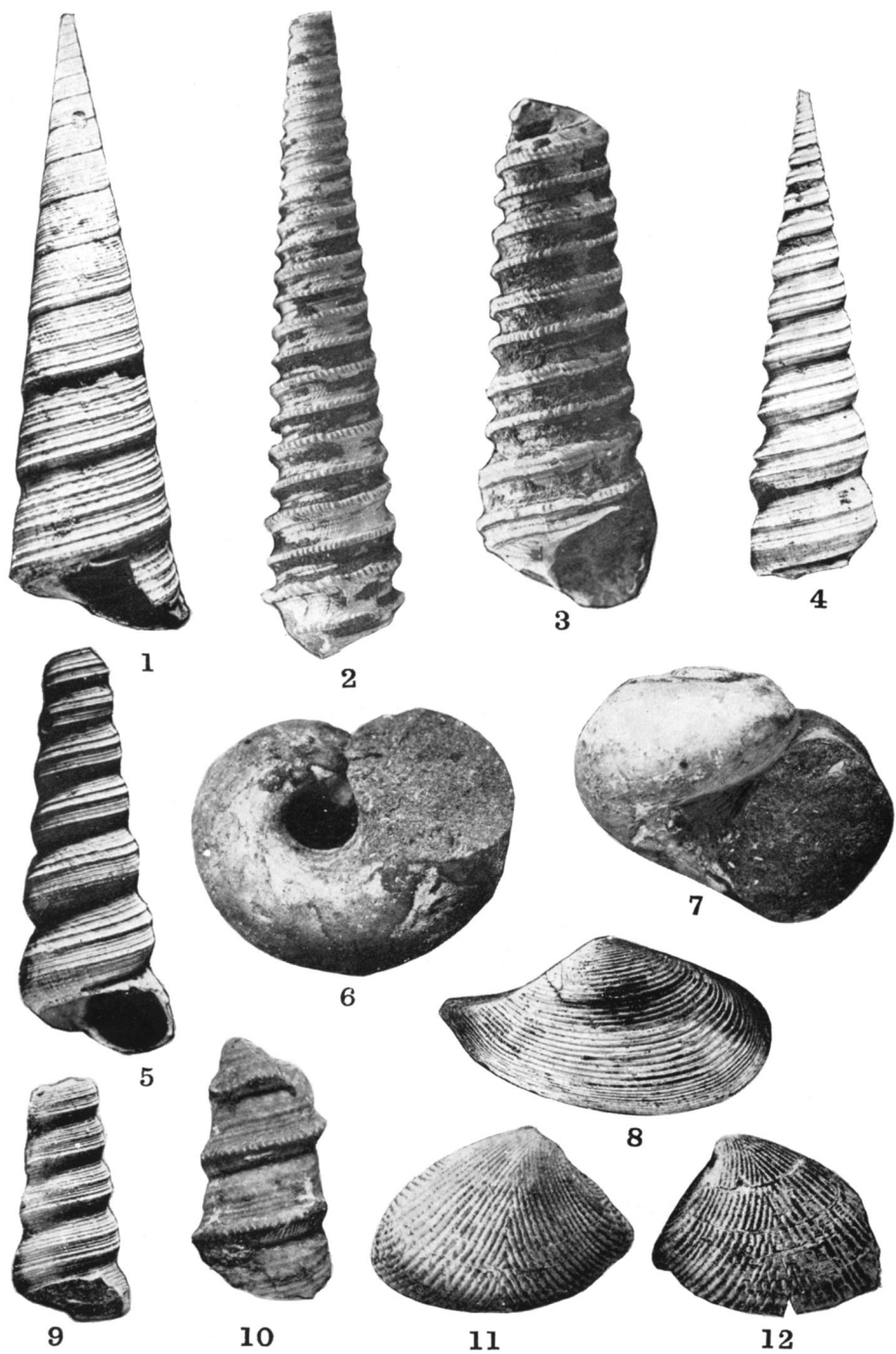
BROWN AND PILSBRY: GATUN FOSSILS.



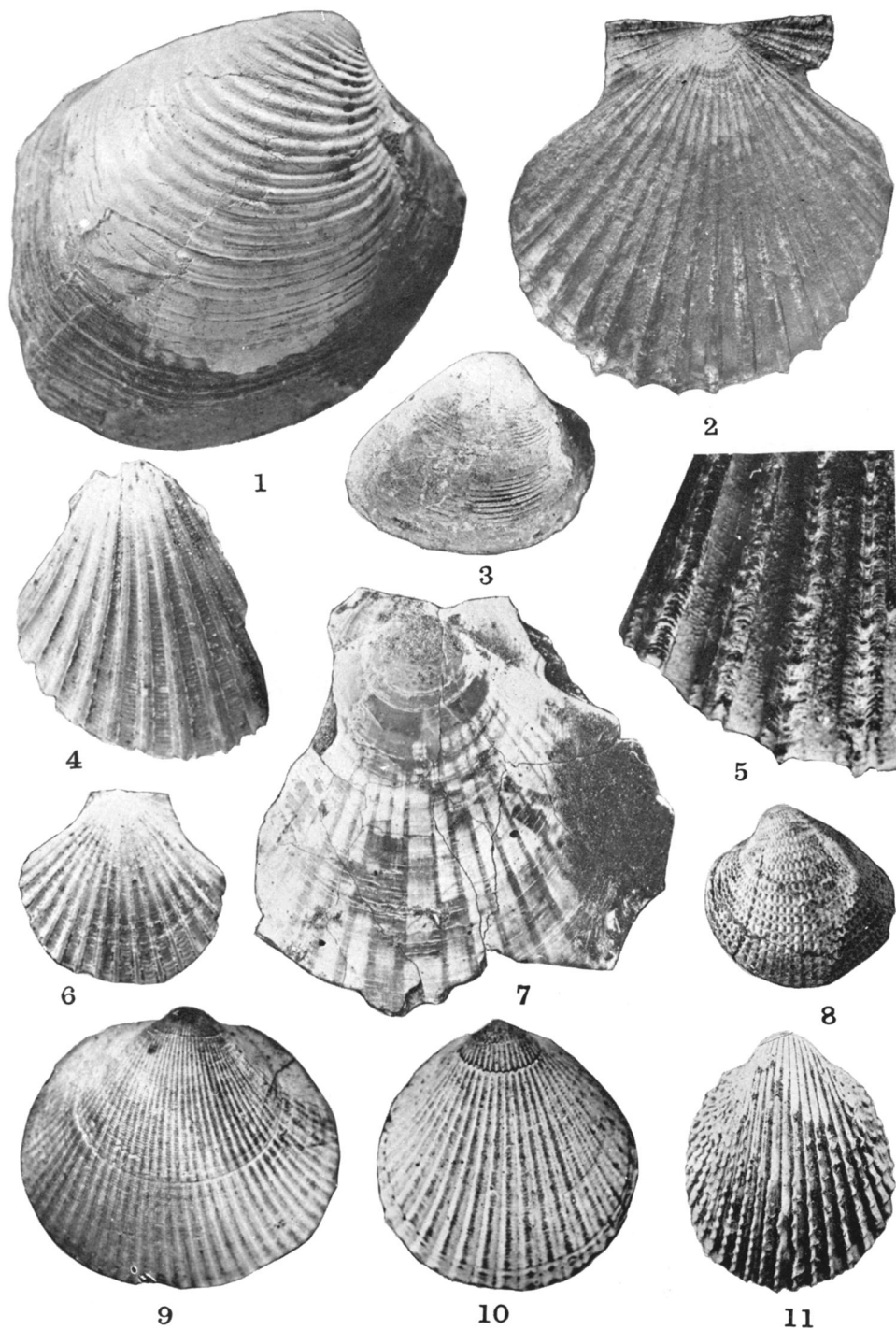
BROWN AND PILSBRY: GATUN FOSSILS.



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